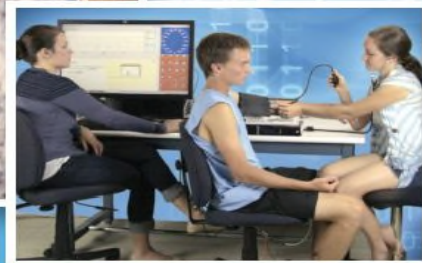


BIOOPAC



BIOPAC
Systems, Inc.
Registered to ISO 9001:2008

*Inspiring people and
enabling discovery about life*

How to get Great Electrodermal Activity (EDA) Data

Frazer Findlay
CEO BIOPAC Systems, Inc.



Our Agenda Today



Setup

Hardware setup

Software setup

Participant setup

Quality

Data quality check

Experiment/Participant

Artifact removal

Analysis

Analysis

Q and A

References

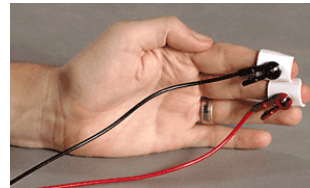
How to get great EDA Data

Hardware Components

MP150 - wired



Reusable:
TSD203 + GEL101

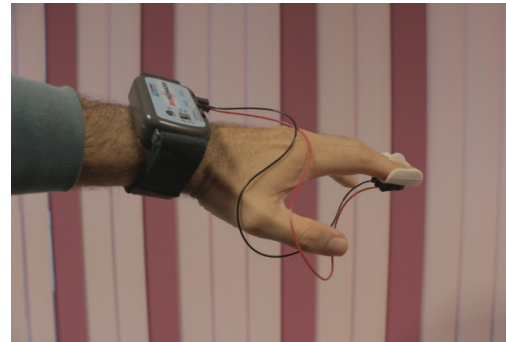
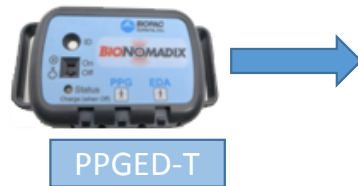


Disposable:
2xLEAD110A + EL507

How to get great EDA Data

Hardware Components

MP150 - wireless



Components:

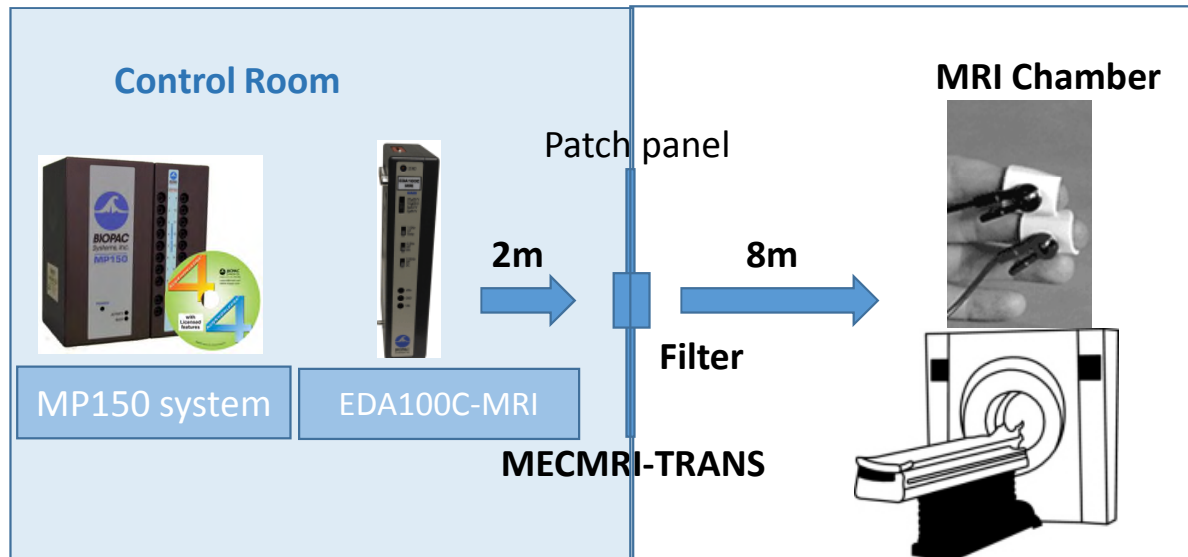
BN-PPGED +
BN-EDA-LEAD2 + EL507



How to get great EDA Data

Hardware Components

MP150 - MRI



Components:

Amplifier: EDA100C-MRI,

Cables and filter: MECMRI-TRANS

Leads: 2xLEAD108B

Electrodes and gel: EL509 + GEL101

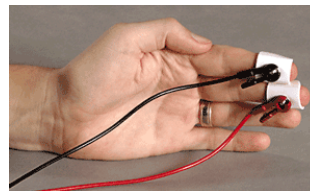
How to get great EDA Data

Hardware Components

MP36R



Reusable:
SS3LA + GEL101



Disposable:
SS57LA + EL507

How to get great EDA Data



Hardware Setup

MP150 - wired

DC mode

Tonic vs. Phasic

5 μS per Volt

Grounding

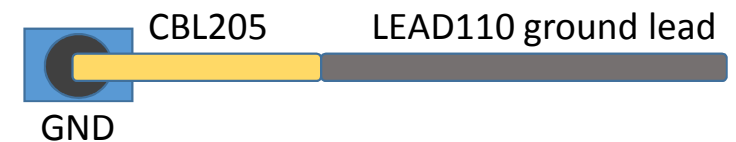
CBL205

Unique channels

μS – micro Siemens;
Unit of electrical conductance

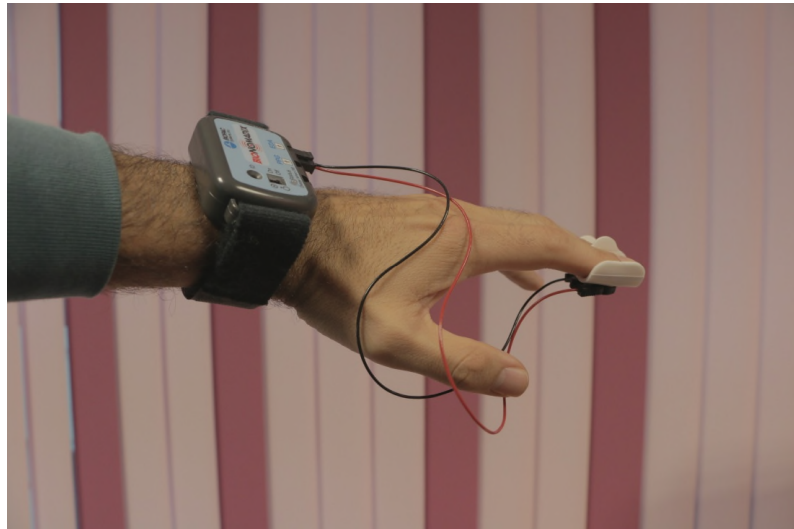
Typical skin conductance levels:
2-20 μS

Range of system at 5 μS per Volt:
0-50 μS





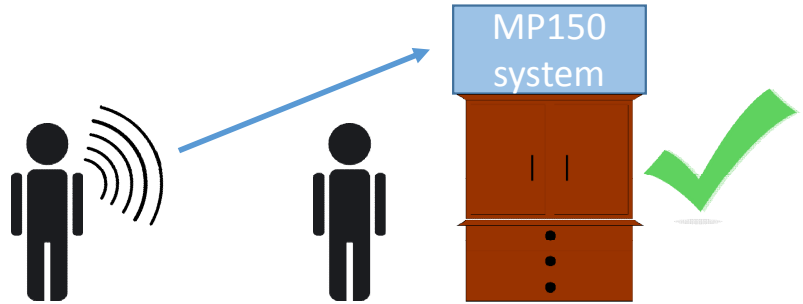
How to get great EDA Data



Hardware Setup
MP150 - wireless

Battery level

Signal transmission





How to get great EDA Data



Hardware Setup

MP150 - MRI

MRI safe/conditional

Only carbon fiber

Safe use of gel

Test outside

Filter grounding

CBL205-MRI

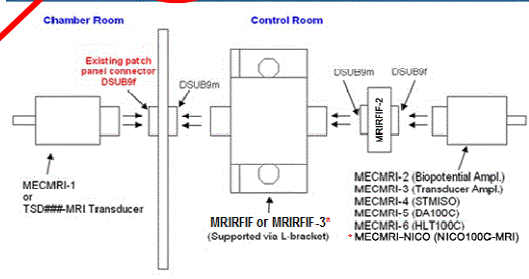
Details Support

COMPATIBILITY

- Biopac Science Lab Systems
- BSL MP36 Systems
- BSL MP45 Systems
- MP150 Research Systems
- MP36R Research Systems

MRI Use: **Conditional to 7T-**

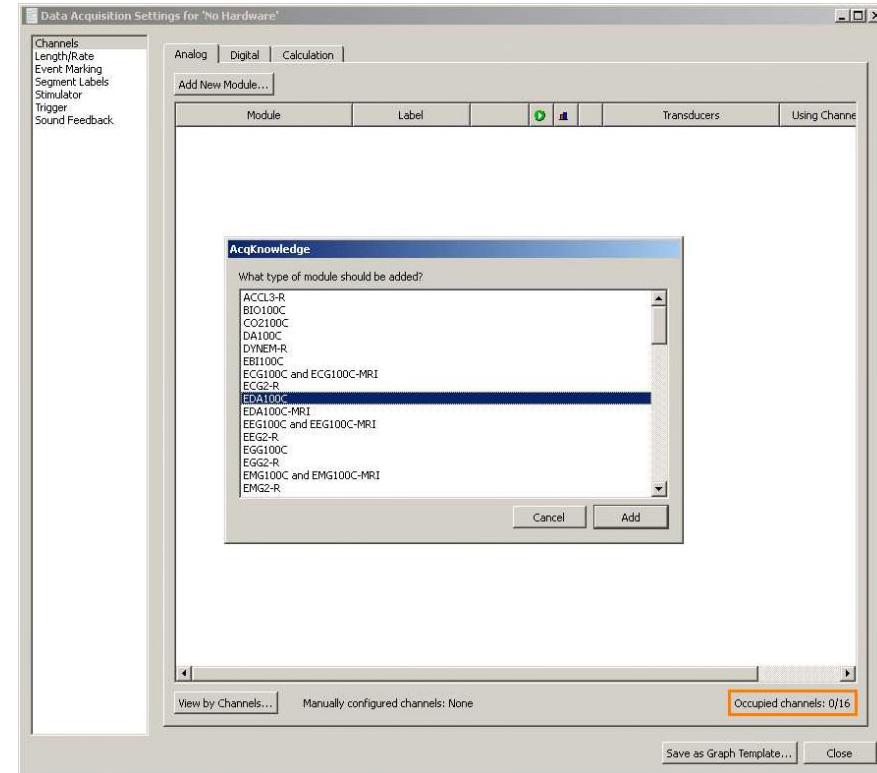
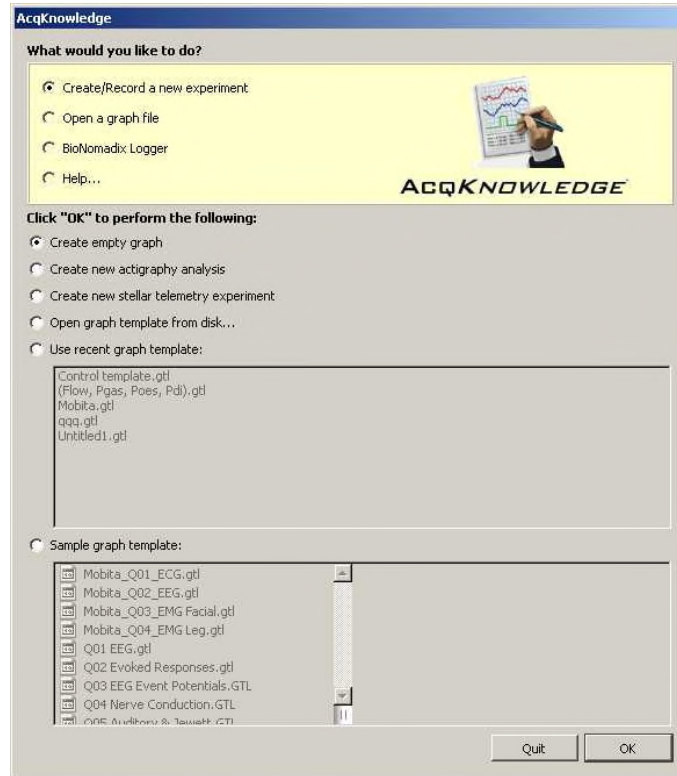
Condition: Up to 7T, any scanning sequence; up to 9T on animals. Use with LEAD108 series only. (See Specifications for components.)





How to get great EDA Data

Software Setup
Channel setup
MP150

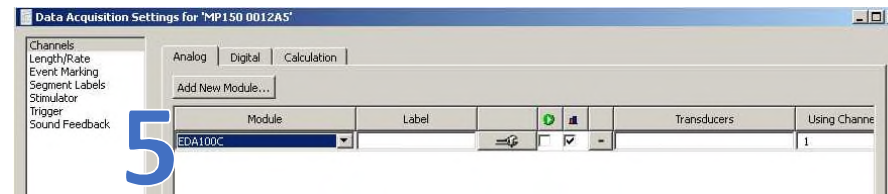
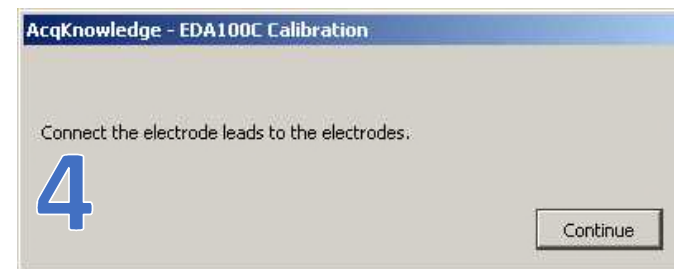
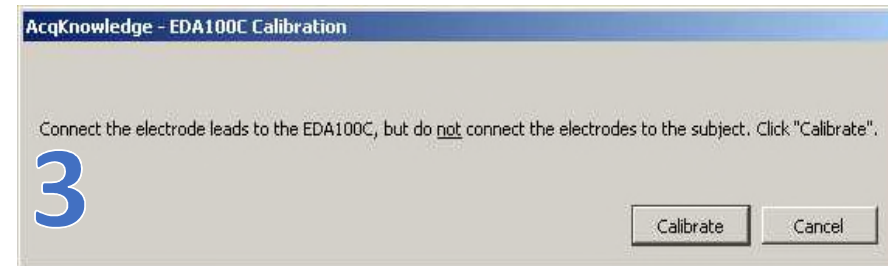
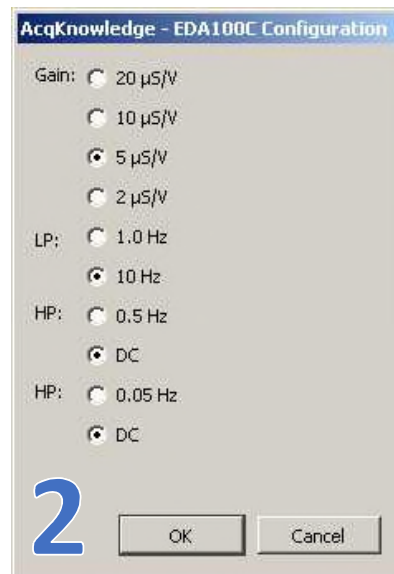
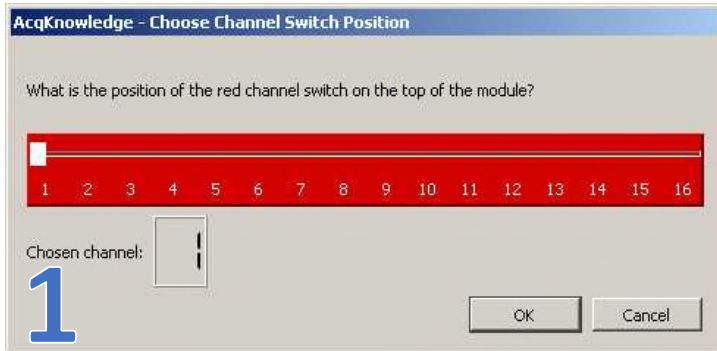




How to get great EDA Data

Software Setup

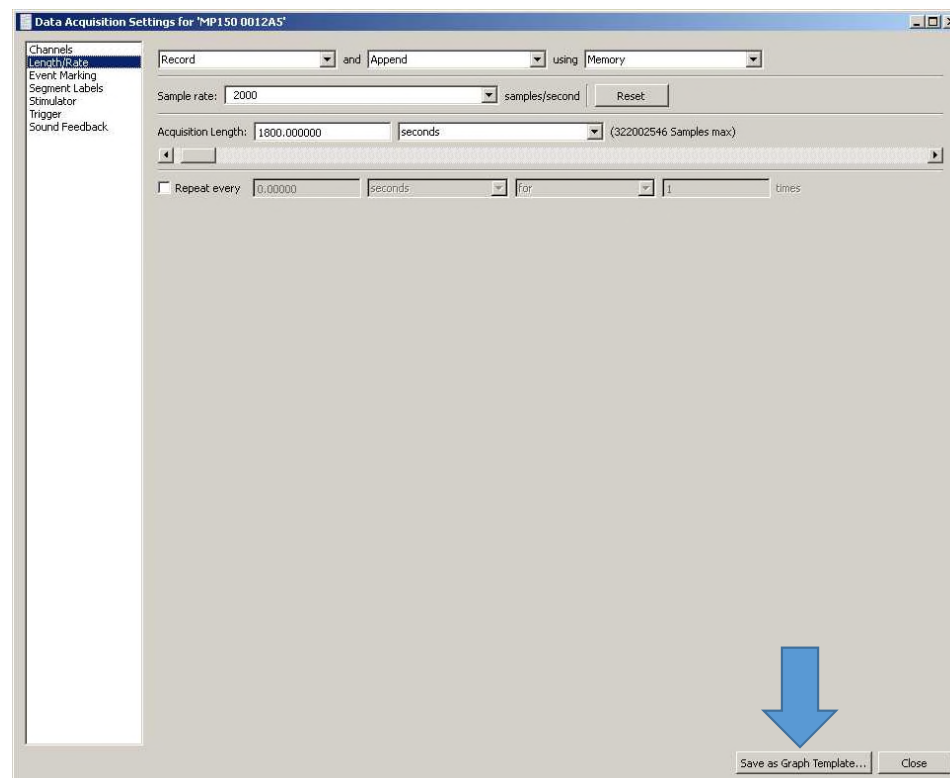
Channel setup MP150



How to get great EDA Data

Software Setup

Channel setup
MP150



[Live Example](#)



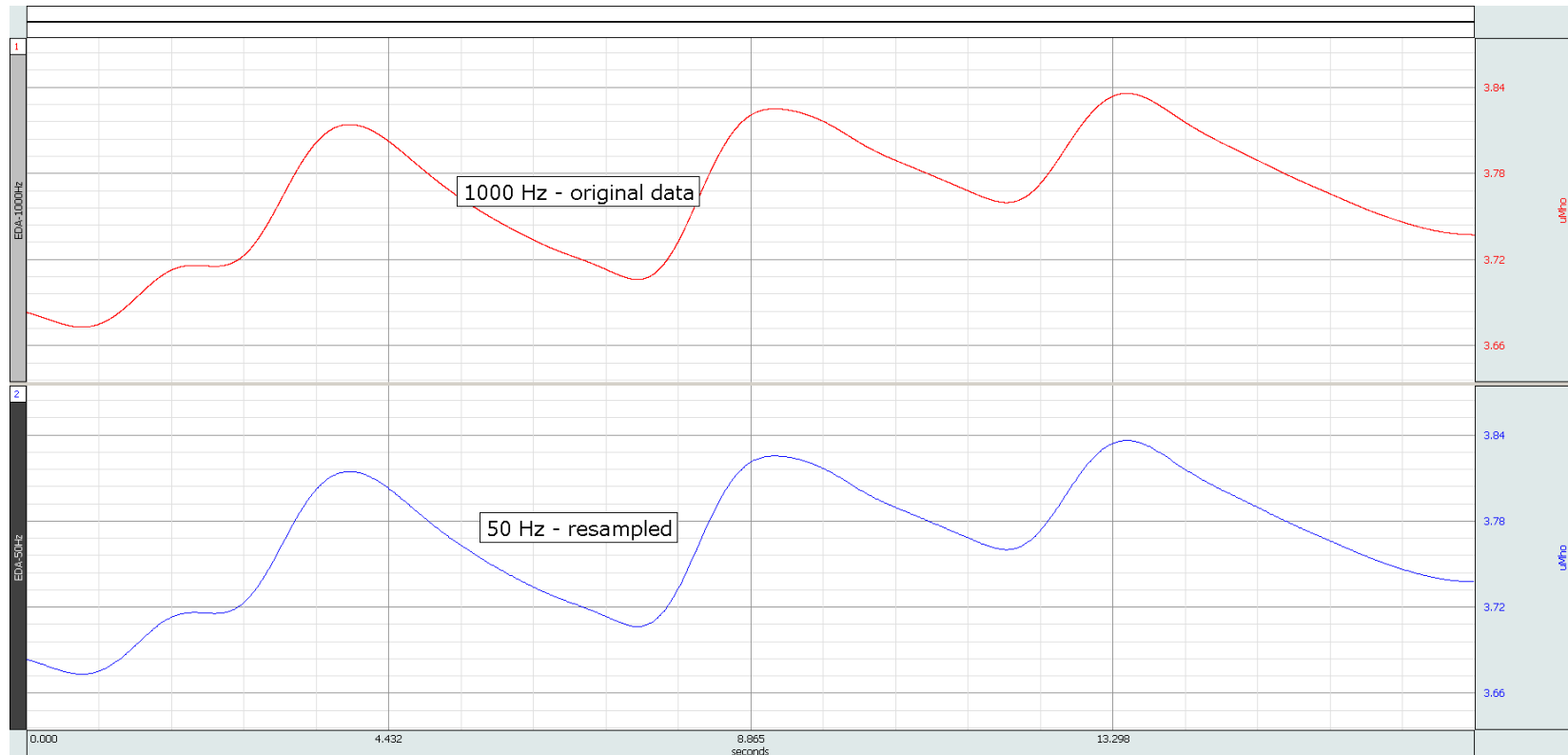
How to get great EDA Data

**Software
Setup**

Sample rate

50 Hz minimum

Sample all
channels at the
same rate





How to get great EDA Data

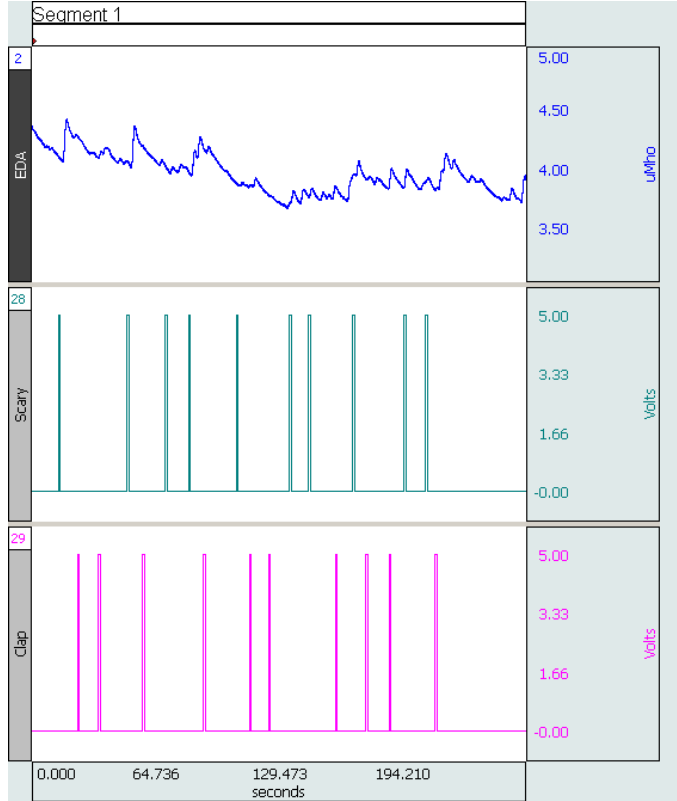
Software Setup
Synchronization

Channels
Length/Rate
Event Marking
Segment Labels
Stimulator
Trigger
Sound Feedback

Analog Digital Calculation

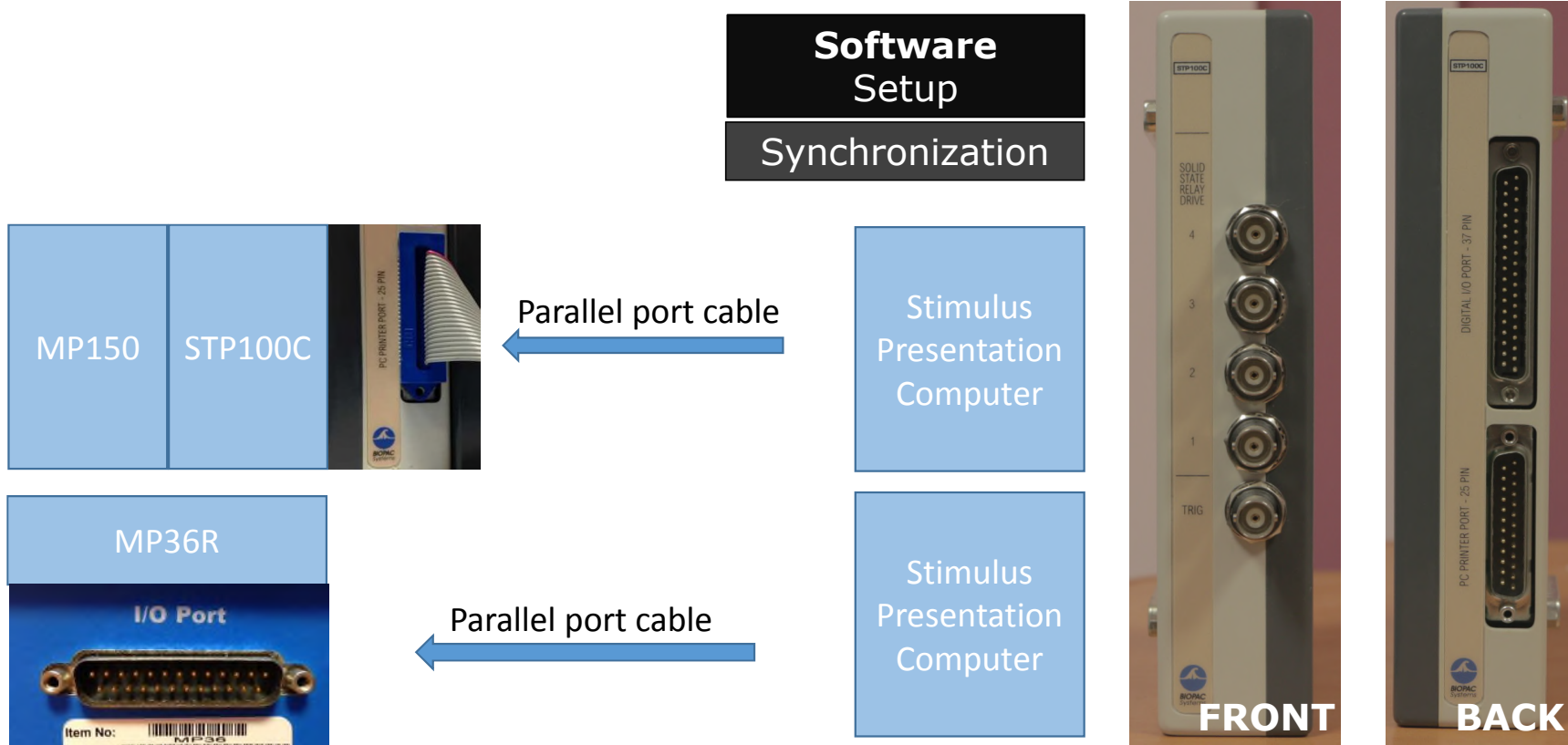
Acquire	Plot	Value	Channel	Label	Channel Sampling Rate
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D0	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D1	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D2	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D3	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D4	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D5	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D6	Digital input	2,000 KHz
<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	D7	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D8	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D9	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D10	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D11	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D12	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D13	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D14	Digital input	2,000 KHz
<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>	D15	Digital input	2,000 KHz

Save as Graph Template... Close





How to get great EDA Data



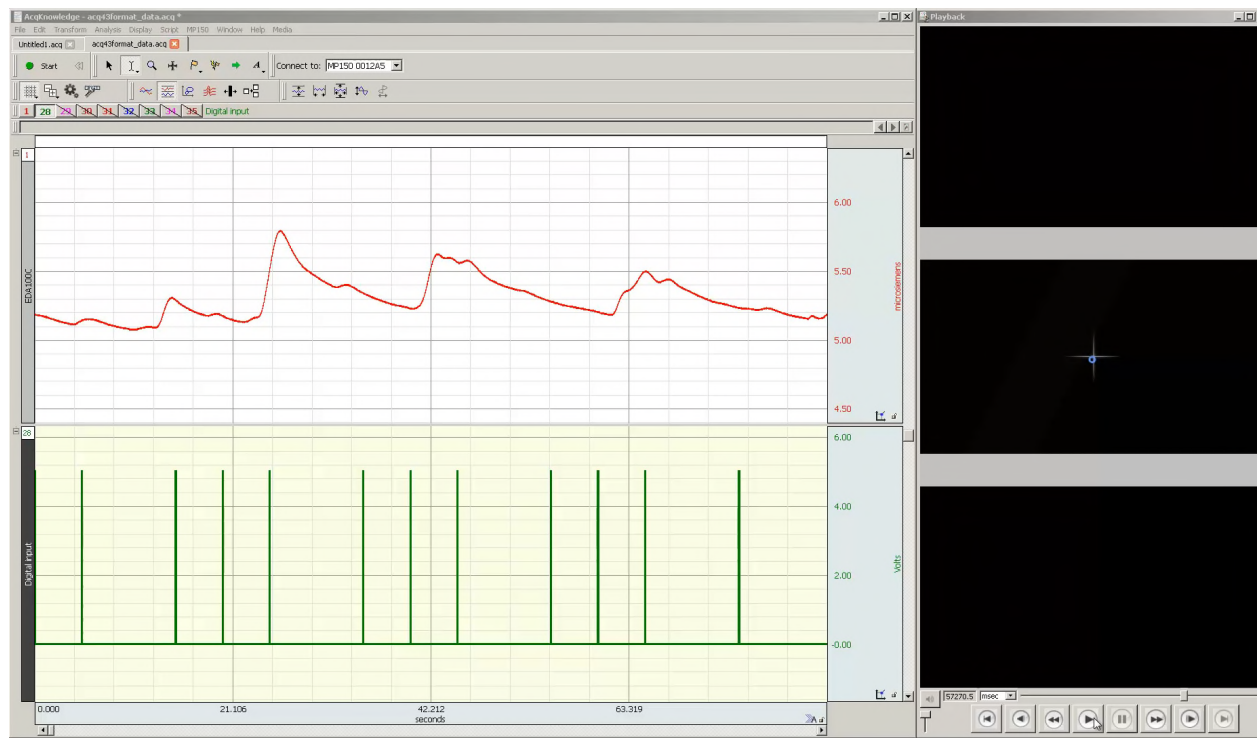
How to get great EDA Data

Software
Setup
Video



How to get great EDA Data

Software
Setup
Video

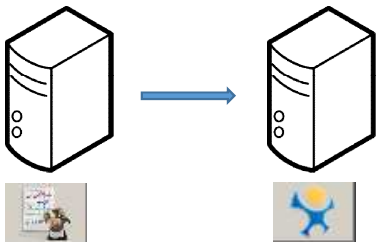




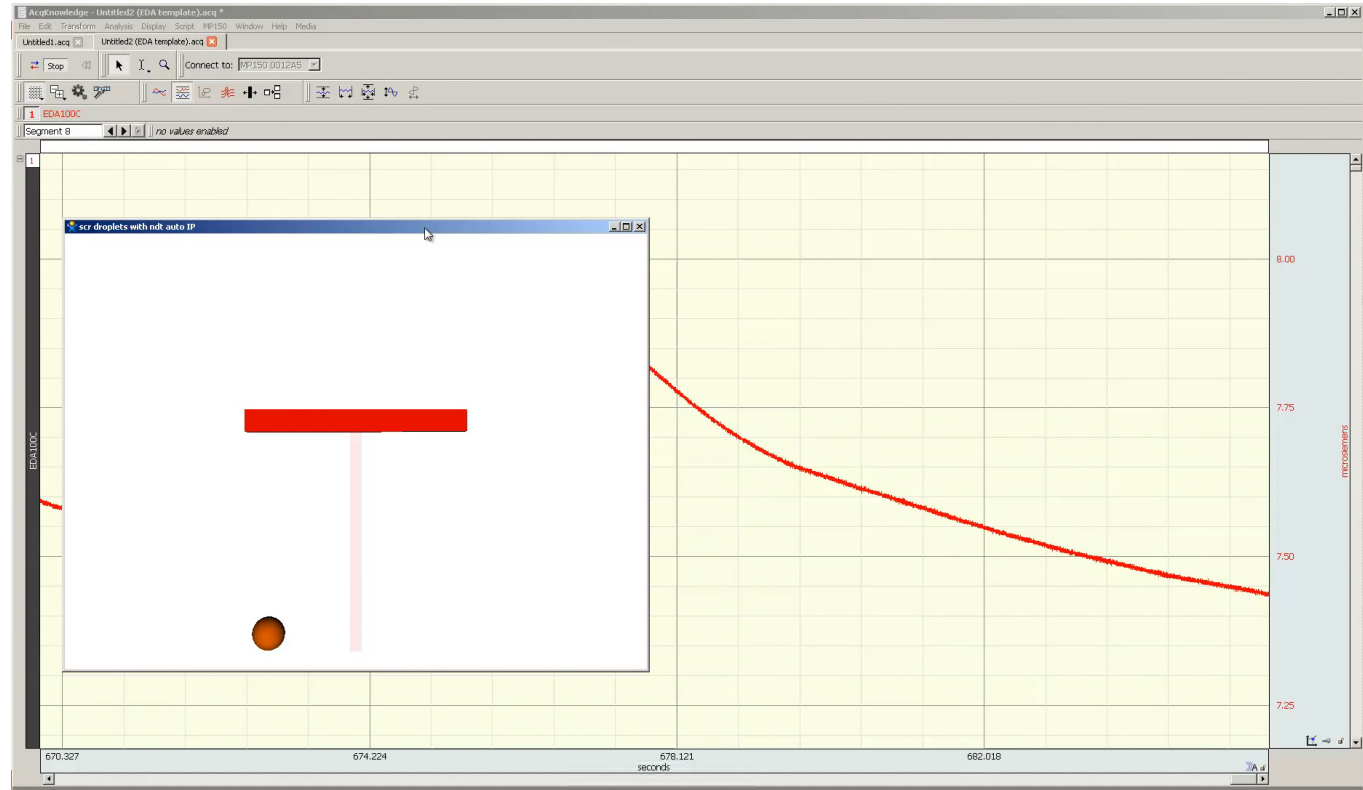
How to get great EDA Data

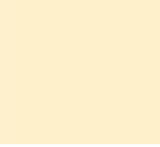
Software Setup

NDT



EDA data sent over the network from AcqKnowledge to Vizard





How to get great EDA Data

Participant Setup

Do not abrade

Skin preparation

Choice of gel

Storage of electrodes

Reviving electrodes

Place at least 5 minutes in advance

Reusable electrodes



GEL101

1



2



3



4

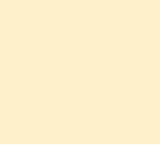


5

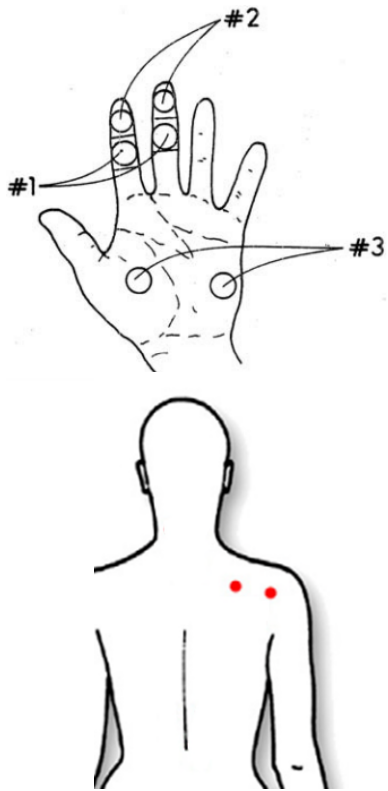


6





How to get great EDA Data



Participant Setup

Ideal placement

Non-dominant hand

Alternate placement

Motion artifacts

Ambient temperature

Table 1

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

How to get great EDA Data

**Data quality
check**

Adaptive scaling

Deep breath

Non-responders

MRI – test outside

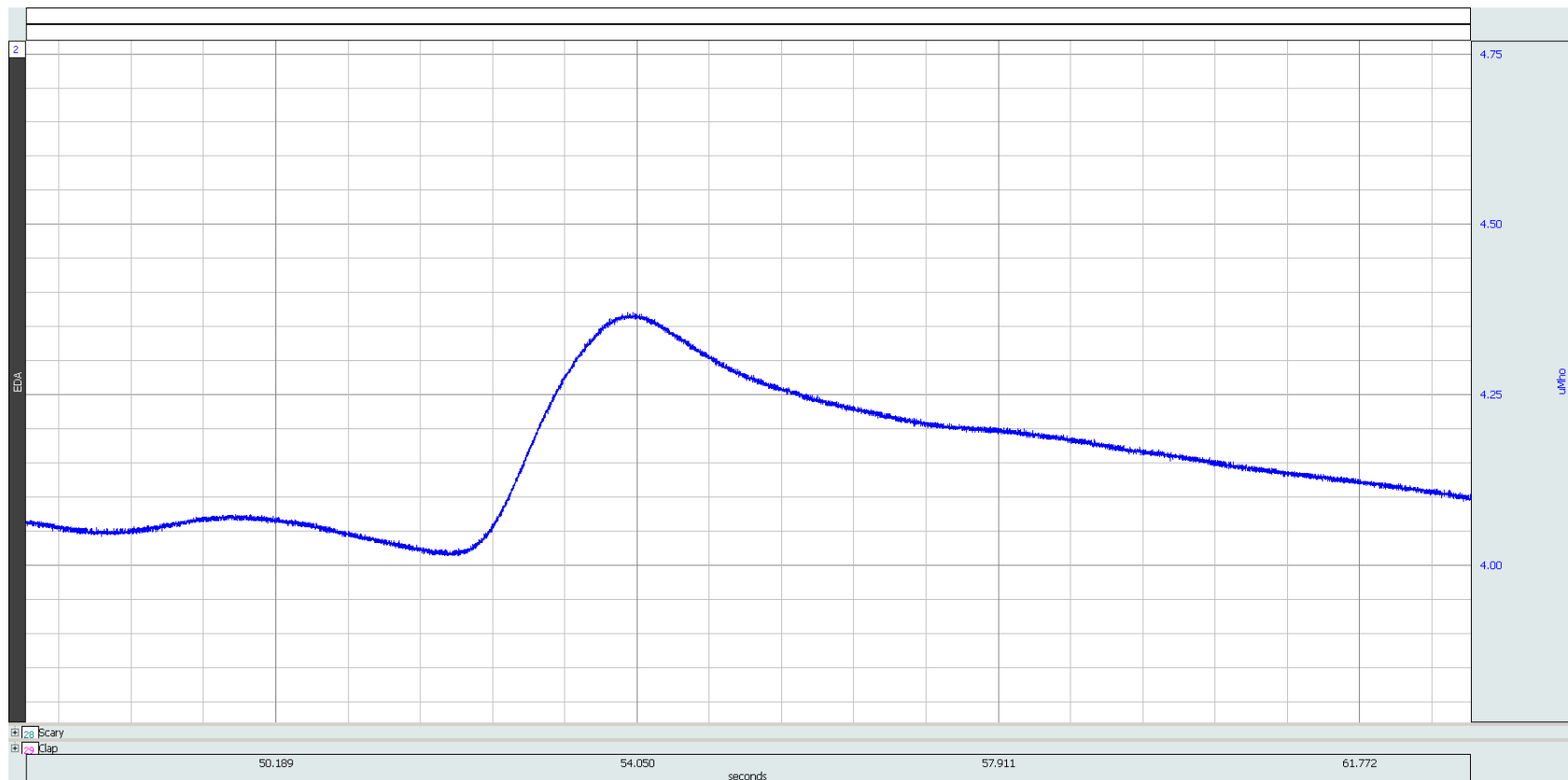
Typical values

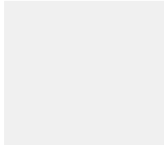
Table 7.1. Electrodermal measures, definitions, and typical values

Measure	Definition	Typical Values
Skin conductance level (SCL)	Tonic level of electrical conductivity of skin	2–20 μ S
Change in SCL	Gradual changes in SCL measured at two or more points in time	1–3 μ S
Frequency of NS-SCRs	Number of SCRs in absence of identifiable eliciting stimulus	1–3 per min
SCR amplitude	Phasic increase in conductance shortly following stimulus onset	0.1–1.0 μ S
SCR latency	Temporal interval between stimulus onset and SCR initiation	1–3 s
SCR rise time	Temporal interval between SCR initiation and SCR peak	1–3 s
SCR half recovery time	Temporal interval between SCR peak and point of 50% recovery of SCR amplitude	2–10 s
SCR habituation (trials to habituation)	Number of stimulus presentations before two or three trials with no response	2–8 stimulus presentations
SCR habituation (slope)	Rate of change of ER-SCR amplitude	0.01–0.5 μ S per trial

Key: SCL, skin conductance level; SCR, skin conductance response; NS-SCR, nonspecific skin conductance response.

How to get great EDA Data









How to get great EDA Data






Artifacts

Good






-  Short sample clean
-  BioNomadix data
-  Very responsive
-  Fast SCL rise

Good vs bad data

Bad

-  With 50/60Hz noise
-  No signal
-  Decoupling from skin
-  Rapid transient
-  HP 0.05Hz applied

Bad

-  Negative EDA
-  Low resolution
-  Large artifact
-  Non-responder
-  Extreme non-responder

How to get great EDA Data

Artifacts

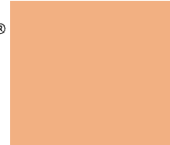
Good vs bad data

Median smoothing

1Hz FIR Low Pass

Connect Endpoints

Automated artifact removal
with scripts



How to get great EDA Data

EDA troubleshooting table

Problem	Probable cause and solution
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
The 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.
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)
Noise throughout the signal	This could be 50Hz/60Hz noise that has been aliased into the data after the 10Hz LP has been applied in the amplifier. It indicates poor connection, most often due to drying gel. Can be usually cleaned up well with 1Hz FIR low pass filter.

How to get great EDA Data

EDA troubleshooting table

Problem	Probable cause and solution
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 uMho per division. You can also apply a 1Hz FIR filter.
Flat line at 10V or equivalent	The gain is too high.
No signal visible onscreen	This is likely an issue with vertical scaling. Display->Autoscale waveforms will make the data visible



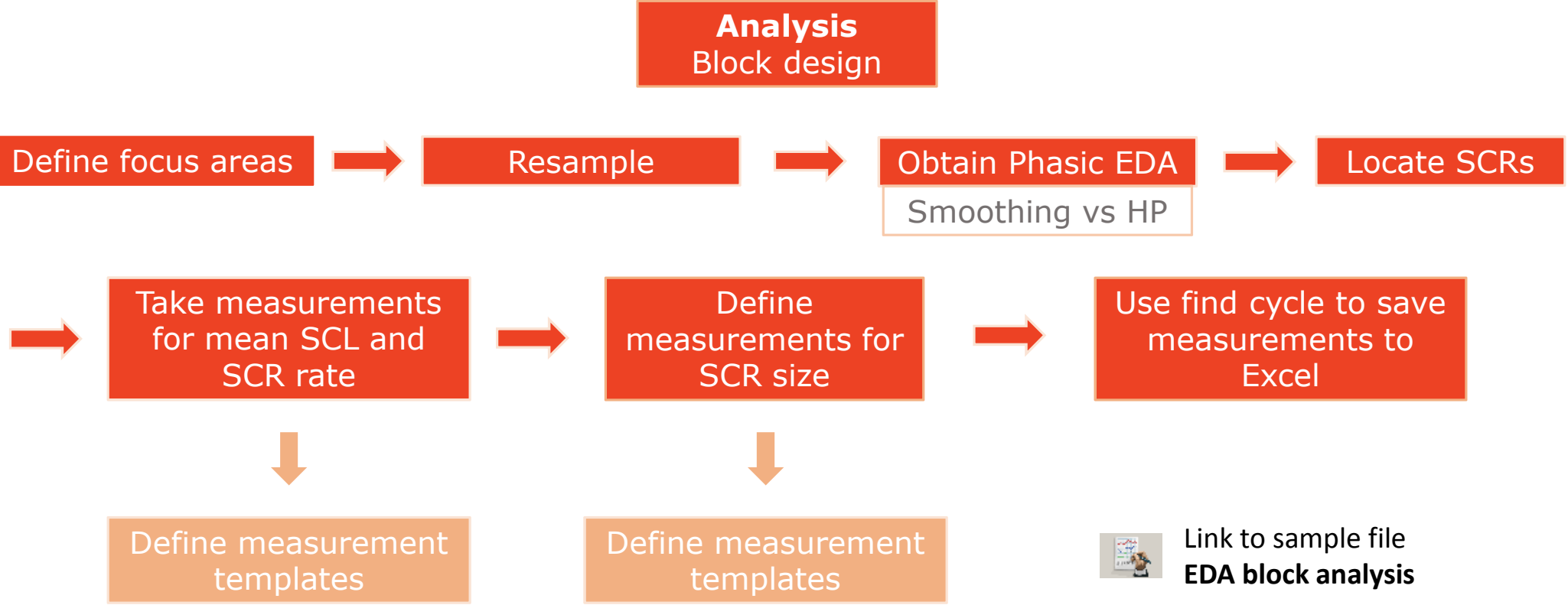
How to get great EDA Data

EDA troubleshooting table

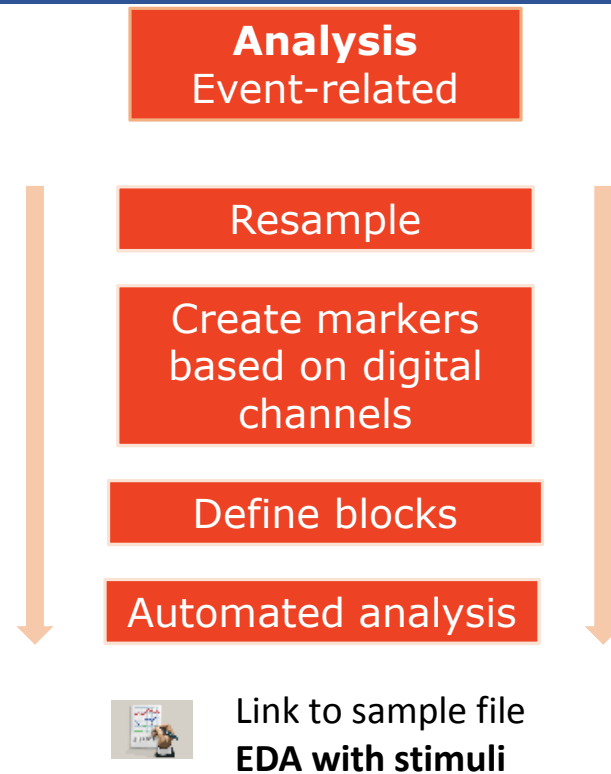
Problem	Probable cause and solution
Data units are volts	To calibrate in uMho/uSiemens, multiply the data by the amplifier gain setting. For example, if the amplifier was set to 5uMho per Volt, then, using Waveform Math, multiply the EDA waveform by 5.
Interference from bioimpedance	See the special cases section here: http://www.biopac.com/knowledge-base/multiple-amplifiers-per-subject-or-multiple-subjects-per-system/
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, 0.05Hz or 0.5Hz is enabled
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 0.5Hz or 0.05Hz high-pass filters may be switched on. Switch to DC mode.



How to get great EDA Data



How to get great EDA Data



How to get great EDA Data

**Analysis
Comments**

Editing SCR markers

Using scripts to automate

Batch processing

Dealing with double SCRs

How to get great EDA Data



References and resources:

Handbook of Psychophysiology. John T. Cacioppo, Gary Berntson, Louis G. Tassinary

Psychophysiology: Human Behavior and Physiological Response by John L. Andreassi

Marieke van Doorena, J.J.G. (Gert-Jan) de Vriesa, Joris H. Janssen (2012) "Emotional sweating across the body: Comparing 16 different skin conductance measurement locations." *Physiology & Behavior*, Volume 106, Issue 2, 15 May 2012, Pages 298–304

White paper: *A Guide for Analyzing Electrodermal Activity (EDA) & Skin Conductance Responses (SCRs) for Psychological Experiments*. Dr Jason J Braithwaite, Dr Derrick G Watson, Robert Jones, Mickey Rowe

K. H. Kim, S. W. Bang and S. R. Kim, "Emotion recognition system using short-term monitoring of physiological signals," *Medical & Biological Engineering & Computing*, vol. 42, pp. 419-427, 2004.

Scerbo, A., Freedman, L. W., Raine, A., Dawson, M. E., & Venables, P. H. (1992). "A major effect of recording site on measurement of electrodermal activity." *Psychophysiology*, 29, 241– 246.

COMMITTEE REPORT. "Publication recommendations for electrodermal measurements." *Psychophysiology*, 49 (2012), 1017–1034.

How to get great EDA Data



Questions and Answers

How to get great EDA Data



What is the appropriate ISI interval?

Must take into account typical latency + rise time + recovery time

How to get great EDA Data

How to calibrate?

1 point calibration or 2-point with 100kOhm resistor

How to get great EDA Data



How to deal with artifacts from electrical stimulation?

Best to optically isolate the stimulator from the rest of the setup

How to get great EDA Data

Recording from multiple participants

Up to 16 participants with one MP150.

Can record from multiple MP150 at once, all in sync.

Wired solutions possible with extended cabling.

Wireless up to about 100 channels per room practical limit.

How to get great EDA Data



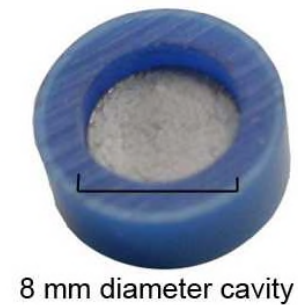
Recording from multiple body locations

The BN-PPGED module is ideal for that as it ensures isolation between locations

How to get great EDA Data

What reusable electrodes are available for the BioNomadix?

EL658 electrodes with adhesive disks can be used but may require taping over to ensure they stay well connected.



How to get great EDA Data



How to measure EDA during sleep?

Use the BioNomadix logger and BN-PPGED. 24 hours of recording can be accomplished With the Logger and you could add more physiological signals + accelerometers, etc.

How to get great EDA Data



For more information:

www.biopac.com

info@biopac.com | support@biopac.com



-**Join us** on June 23rd at 8:00 AM PDT for "Getting Great EDA Data Part 2: Analysis Essentials"

-**Register** at www.biopac.com/webinars

Thank you for your time and attention!