This Guide provides an overview of all of the functionality available from the PSM Training system, and OmniSense application software.

For detailed step by step instructions, refer to one of the Training Modules.

Training Modules:

**Live Training**
1. System Setup  
2. Database Setup  
3. Live Operations  
4. Pebble Watch & Application  
5. Baseline Fitness Testing

**Analysis Training**
1. Overview  
2. Graph Options  
3. Log Data  
4. Reports  
5. Fitness Considerations  
6. Impact Analysis  
7. Readiness  
8. Fitness Test Analysis  
9. Software Utilities

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## Contents

GLOSSARY .......................................................................................................................... 5
INTRODUCTION .................................................................................................................. 6
  Overview ............................................................................................................................ 7
  The PSM System .............................................................................................................. 8
RADIO NETWORK OPTIONS ............................................................................................... 9
PHYSIOLOGICAL PARAMETERS ....................................................................................... 11
COMPONENTS ................................................................................................................... 14
  BioModule .......................................................................................................................... 15
  Garment Options .............................................................................................................. 16
  Echo .................................................................................................................................. 16
  System Case .................................................................................................................... 17
  Charge Cradle .................................................................................................................. 17
  Pebble Watch .................................................................................................................. 17
  External Sensors ............................................................................................................. 18
  GPS ................................................................................................................................... 18
  Barcode Scanner ............................................................................................................. 19
  Bluetooth Antenna ......................................................................................................... 19
  Motorola Radios ............................................................................................................. 20
  Tactical Radios ............................................................................................................... 20
  Legacy Systems .............................................................................................................. 20
OMNISENSE LIVE ............................................................................................................. 21
  Overview .......................................................................................................................... 22
  Settings ............................................................................................................................. 23
  Setup Screens .................................................................................................................. 24
  Barcode Deployment ....................................................................................................... 25
  Live Screen ...................................................................................................................... 26
  BioGauge .......................................................................................................................... 27
  Details Tab ........................................................................................................................ 28
  Accel Tab ......................................................................................................................... 29
  Comms Tab ...................................................................................................................... 30
  Map Tab ............................................................................................................................. 31
  Medic Tab .......................................................................................................................... 32
  Safety Tab ........................................................................................................................ 33
  Training Tab ..................................................................................................................... 34
  Workout Tab .................................................................................................................... 35
  Baseline Fitness Testing .................................................................................................. 36
LIVE OPERATIONS ............................................................................................................ 37
  Preparation ....................................................................................................................... 38
  Issue Components ......................................................................................................... 39
  Strap Fitting ..................................................................................................................... 40
  Repeater Location .......................................................................................................... 41
  Startup Sequence ............................................................................................................ 42
# PSM Training User Guide

## PEBBLE WATCH & ZEPHYR WATCH APPLICATION

- OMNISENSE ANALYSIS ................................................................. 44
  - Overview .................................................................................. 47
  - Physiological Parameters ....................................................... 48
  - Workflow .................................................................................. 49
  - Time Graphs ............................................................................. 50
  - Time Graph Operations ........................................................... 51
  - Fitness Testing .......................................................................... 52
  - Summary Graphs ...................................................................... 53

## REPORTS

- Training Reports Overview .................................................... 55
- Group Consolidation Summary – All Parameters ..................... 56
- Periodization – Intensity & Load Parameters ......................... 57
- GPS – Speed, Distance & Elevation Parameters .................... 58
- Workout Compliance – Intensity, Load & Training Zone Parameters 59

## LOG DATA

- IMPACT ANALYSIS ..................................................................... 62

## READINESS

- MANAGE DATA ........................................................................... 66

## UTILITIES

- Zephyr Config Tool .................................................................... 68
- Zephyr Updater .......................................................................... 69
- BioHarness Log Downloader ..................................................... 70
- Kubios Converter ........................................................................ 71
- Data Plotter ................................................................................. 72

## WARRANTY & END USER LICENSE AGREEMENT (EULA)

- ..................................................................................................... 74
<table>
<thead>
<tr>
<th>AT</th>
<th>Anaerobic Threshold – closely associated with 2nd ventilatory threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLE</td>
<td>Bluetooth Low Energy / Bluetooth Smart / Bluetooth 4.0</td>
</tr>
<tr>
<td>BPM</td>
<td>Beats per minute (Heart rate) or Breaths per minute (Breathing rate)</td>
</tr>
<tr>
<td>BR</td>
<td>Breathing Rate</td>
</tr>
<tr>
<td>BRAT</td>
<td>Barcode Rapid Allocation Tool</td>
</tr>
<tr>
<td>BT</td>
<td>Bluetooth®</td>
</tr>
<tr>
<td>ECG /EKG</td>
<td>Electro Cardio Gram</td>
</tr>
<tr>
<td>ECHO</td>
<td>2.4 GHz 802.15.4 Radio Network type used by this system</td>
</tr>
<tr>
<td>Gateway</td>
<td>Receiver device connected to PC</td>
</tr>
<tr>
<td>GPS</td>
<td>Global Positioning System</td>
</tr>
<tr>
<td>HR</td>
<td>Heart Rate</td>
</tr>
<tr>
<td>HR max</td>
<td>Maximum heart rate of an individual subject</td>
</tr>
<tr>
<td>HRV</td>
<td>Heart Rate Variability</td>
</tr>
<tr>
<td>LED</td>
<td>Light Emitting Diode</td>
</tr>
<tr>
<td>KML</td>
<td>Keyhole Markup Language – Google Earth file format</td>
</tr>
<tr>
<td>PC</td>
<td>Personal Computer</td>
</tr>
<tr>
<td>PSM</td>
<td>Physiological Status Monitoring [system]</td>
</tr>
<tr>
<td>RH</td>
<td>Relative Humidity</td>
</tr>
<tr>
<td>RID</td>
<td>Zephyr™ Radio Interface Device</td>
</tr>
<tr>
<td>ROG</td>
<td>Red / Orange / Green[ subject physiological status indication]</td>
</tr>
<tr>
<td>USB</td>
<td>Universal Serial Bus – PC hardware connection</td>
</tr>
<tr>
<td>VMU</td>
<td>Velocity Magnitude Unit – a measure of activity level (in g) over a fixed time interval</td>
</tr>
</tbody>
</table>
Overview

The PSM System transmits live physiological data from multiple (up to 100) subjects via a radio link to a remote station.

Live data is displayed in OmniSense Live on a configurable BioGauge, including:

- Heart Rate
- Activity Level
- Stress
- Breathing Rate
- Est. Core Temperature
- Training Intensity
- Orientation
- Impact Data
- & Many others

All data is stored in a database for display and analysis in OmniSense Analysis.

Data is also logged internally in the BioModule and can be imported into the OmniSense database, when Live viewing is not required, or not possible.
The PSM System

Zephyr BioHarness®

GPS

Remote relay of multiple physiological parameters, including
- Heart Rate
- Breathing Rate
- Activity Level
- Estimated Core Temperature
- Subject Orientation

OmniSense

Omnisense Live streaming data display

Visual sweep scale and color-coded display, fully configurable

ECHO Field Repeater

Red/Orange/Green subject status algorithms

ECHO Gateway

Full data recording and display using OmniSense Analysis

Pebble Watch

Support of up to 100 subjects

Fitness and Training Reports

Support of up to 100 subjects

Range of up to 600 yards with optional field repeaters

Optional GPS Speed & Distance, and Map display with supported Bluetooth GPS

Optional individual feedback using Pebble Watch

Optional additional sensors for Blood Pressure & Oxygen Saturation

Fitness Testing

Workouts

Record all data on the BioModule and import into the database
Radio Network Options
PSM Training ECHO: Range to 600 yards. 20 / 50 / 100 subjects. 1s / 2.5s / 5s data update rate

PSM Bluetooth Direct: Range to 100 feet. 7 subjects. 1s data update rate

PSM Responder: Range per Motorola Network. 64 subjects. 1s data update rate

PSM Defense: Range per Tactical Radio Network. 64 subjects. Data update rate network dependent.

Refer to the Live Training > Setup module
Can be displayed in OmniSense Live & OmniSense Analysis

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate</td>
<td>Beats/minute</td>
<td></td>
</tr>
<tr>
<td>Breathing Rate</td>
<td>Breaths/minute</td>
<td></td>
</tr>
<tr>
<td>Heart Rate Variability</td>
<td>Milliseconds</td>
<td>After five minutes</td>
</tr>
<tr>
<td>Estimated Core Temperature</td>
<td>Degrees F/C</td>
<td>HR based</td>
</tr>
<tr>
<td>Impact</td>
<td>g</td>
<td></td>
</tr>
<tr>
<td>Activity Level</td>
<td>VMU</td>
<td>Walk ~ 0.2 VMU, Run ~ 0.8 VMU</td>
</tr>
<tr>
<td>Calories</td>
<td>kCal</td>
<td>Heart Rate based calculation</td>
</tr>
<tr>
<td>% Maximum Heart Rate</td>
<td>%</td>
<td>Maximum as saved from Fitness tests</td>
</tr>
<tr>
<td>% Heart Rate at AT</td>
<td>%</td>
<td>HR @ AT as saved from Fitness Tests</td>
</tr>
<tr>
<td>Physical Intensity</td>
<td>0 – 10 scale</td>
<td>Based on Heart Rate</td>
</tr>
<tr>
<td>Mechanical Intensity</td>
<td>0 – 10 scale</td>
<td>Based on Movement</td>
</tr>
<tr>
<td>Training Intensity</td>
<td>0 – 10 scale</td>
<td>Average of Phys + Mech</td>
</tr>
<tr>
<td>Physical Load</td>
<td>Accumulating Index</td>
<td>Accumulation of Phys. Intensity</td>
</tr>
<tr>
<td>Mechanical Load</td>
<td>Accumulating Index</td>
<td>Accumulation of Mech. Intensity</td>
</tr>
<tr>
<td>Jump Force</td>
<td>g</td>
<td>Static Jump. Specific criteria.</td>
</tr>
<tr>
<td>Explosiveness</td>
<td>g</td>
<td>From 40 yard dash test. Specific criteria.</td>
</tr>
<tr>
<td>Stress Level</td>
<td>0 – 10 scale</td>
<td>Calculated from HRV.</td>
</tr>
<tr>
<td>Saturated Blood Oxygen</td>
<td>%</td>
<td>Additional sensor required</td>
</tr>
<tr>
<td>Blood Pressure</td>
<td>mmHg</td>
<td>Additional sensor required</td>
</tr>
<tr>
<td>Speed</td>
<td>Miles Per Hour</td>
<td>GPS required</td>
</tr>
<tr>
<td>Distance Travelled</td>
<td>Miles</td>
<td>GPS required</td>
</tr>
<tr>
<td>Elevation</td>
<td>Feet above sea level</td>
<td>GPS required</td>
</tr>
<tr>
<td>Heart Rate Confidence</td>
<td>%</td>
<td>Based on ECG signal quality and other factors</td>
</tr>
<tr>
<td>BioModule Battery Level</td>
<td>% Full charge</td>
<td>For Bluetooth &amp; ECHO only.</td>
</tr>
<tr>
<td>Physiological Status</td>
<td>Red/Orange/Green</td>
<td>Algorithm uses HR, HR, Activity Level</td>
</tr>
<tr>
<td>Accelerometer Waveform</td>
<td>g</td>
<td>Single selected subject, 3 axis</td>
</tr>
<tr>
<td>Vertical/Lateral/Sagittal</td>
<td>g</td>
<td>Over previous epoch (1 / 2.5 / 5 s)</td>
</tr>
<tr>
<td>Acceleration</td>
<td>g</td>
<td></td>
</tr>
<tr>
<td>Vertical/Lateral/Sagittal</td>
<td>g</td>
<td>GPS required. Map display.</td>
</tr>
<tr>
<td>Min/Max Acceleration</td>
<td>g</td>
<td>GPS required. Based on Robbins Periodization system.</td>
</tr>
<tr>
<td>Location</td>
<td>Latitude/Longitude</td>
<td>4-color. Based on Robbins Periodization system.</td>
</tr>
<tr>
<td>Workout Zone</td>
<td>Color coded</td>
<td>4-color.</td>
</tr>
<tr>
<td>Training Zone</td>
<td>Color coded</td>
<td>4-color.</td>
</tr>
<tr>
<td>Average Rate Force Development</td>
<td>Newton/s</td>
<td>Measure of explosiveness</td>
</tr>
<tr>
<td>Average Step Impulse</td>
<td>Newton</td>
<td>Measure of efficiency of steps</td>
</tr>
<tr>
<td>Average Step Period</td>
<td>Seconds</td>
<td>Step duration</td>
</tr>
<tr>
<td>Flight Time</td>
<td>Seconds</td>
<td>Jump time in the air</td>
</tr>
<tr>
<td>Peak Magnitude Phi</td>
<td>Degrees</td>
<td>Degrees from vertical of impact direction</td>
</tr>
<tr>
<td>Peak Magnitude Theta</td>
<td>Degrees</td>
<td>Degrees from front horizontal of impact direction</td>
</tr>
<tr>
<td>Impulse Load</td>
<td>Newton</td>
<td>Total impulse load</td>
</tr>
<tr>
<td>Walk Step Count</td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>Run Step Count</td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>Bound Count</td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>Jump Count</td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>Minor Impacts</td>
<td>Count</td>
<td></td>
</tr>
<tr>
<td>Major Impacts</td>
<td>Count</td>
<td></td>
</tr>
</tbody>
</table>
Available by Downloading Log Data from an individual BioModule and exporting to an external .csv file

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ECG Waveform</td>
<td>Bits</td>
<td>Convertible to mV. 100Hz.</td>
</tr>
<tr>
<td>Accelerometer Raw Waveform</td>
<td>Bits</td>
<td>3-axis. Convertible to g. 250 / 1000 Hz.</td>
</tr>
<tr>
<td>KML file</td>
<td></td>
<td>Google Earth file containing location data &amp; embedded vital signs (can also be exported from Analysis module)</td>
</tr>
</tbody>
</table>
Components
BioModule

- Connectivity
  - ECHO transmitter module
  - Bluetooth + Bluetooth Low Energy transmitter module
  - USB for PC configuration

- Internal Data Logging, up to 450 hours

- Log download by USB or Bluetooth

- Battery duration up to 35 hours

- 3 hour battery charge time

- IP67 Water Resistant

- Configurable Firmware

- Barcode Labelling for rapid deployment

- 250 Hz ECG

- 100 Hz 16g 3-Axis Accelerometer

- Capacitive Breathing Detection

- Supports Bluetooth GPS

- Supports BLE Pebble Watch

- Supports external sensors for Blood Oxygen, Blood Pressure

- Internal algorithms for
  - Subject ROG status
  - Estimated Core Temperature
  - Jump & Dash Tests
  - Heart Rate Variability

---

For more information, refer to the BioHarness 3 Data Sheet
Garment Options

- BioHarness
  - Left side BioModule location
  - Integrated ECG & capacitive breathing sensors
  - Adjustable, elasticized
  - Fabric-based
  - Detachable shoulder strap
  - Machine washable
  - Biocompatible

- Loose Shirt
  - Left side BioModule location
  - Integrated BioHarness strap with low-profile buckle
  - Flame Resistant
  - Semi-fitted athletic style
  - Quick Dry
  - Machine Washable
  - Male & Female fitting

- Compression Shirt
  - Center chest BioModule location
  - Tight fit
  - Polyester Lycra body
  - Integrated ECG sensor only
  - GPS pocket

- Garment type is set in OmniSense Live

Echo

- ECHO Gateway
  - USB Connection for power
  - Plug and Play
  - 300 yard range
  - Short or long antenna options

- Field Repeater
  - External Power or Internal Battery (24 hrs/ 5300 mAh)
  - 3 hour charge time
  - Maximum of 4 repeaters per ECHO system
  - Extend range to 600 yards
System Case

- 50 device capacity
- USB Connectivity to PC
- Configure BioModules
- Log Download by USB or Bluetooth
- External power or internal rechargeable battery
- Tough, durable storage and transportation for BioModules

Charge Cradle

- 5 device capacity
- USB Mini Connectivity to PC
- Configure BioModules
- Log Download by USB or Bluetooth
- External power pack supplied

Pebble Watch

- Bluetooth Low Energy connection to BioModule BH3-LE
- Integrated Zephyr application
- 3 configurable screen fields
- Heart Rate, HRV, Breathing Rate, Activity Level, Posture, Training Zone, Stress
- 1 – 60 s update rate
External Sensors

- PSM Bluetooth Direct only
- Add Sensors by Bluetooth in OmniSense Live

- Automatic reading initiation
- For a selected subject
- Set reading interval in OmniSense Live

Refer to the Live Training > Live Operations module

GPS

- Add Sensors by Bluetooth in OmniSense Live
- Speed, Distance Travelled & Location
- Barcode labelling for rapid deployment
- USB charge cradle supports both devices

- Support Streaming map display in OmniSense Live
- KML file export from OmniSense Analysis
- 1300ST armband available

Refer to the Live Training > Setup & Live Operations modules
Barcode Scanner

- Assign BioModules & GPS to subjects
- Assign Subjects to Teams
- Start Live operations

OmniSense Live Rapid Deployment Tool

- Integrated Tool in OmniSense Live
- Use device labels or printed sheets
- Wired (DS4208) or wireless (DS3578) scanner support

Bluetooth Antenna

- For Bluetooth Direct systems
- USB Connectivity
- Extend range to 100 feet

AirCable XR3

Refer to the Live Training – Live Operations modules
Motorola Radios

- For PSM Responder systems
- XPS – P25 Conventional & Trunking modes supported
- XPS – Zephyr Bluetooth BioMic or radio interface device (RID)
- Gateway Radio connects to PC by USB
- XTS 1500, 2500 & 5000 & APX7000 supported

Tactical Radios

- A variety of tactical radio systems are supported
- Contact Zephyr Technology for details

Legacy Systems

These legacy systems are no longer supported in OmniSense 4.0:
- ISM BioModules
- Zephyr Z-Modem systems
- Bluetooth Access Point systems

All of these systems are no longer in production.
Overview

Live Screen
- Subject BioGauges
- 4 x Team tabs
- Trend Graphs
- Accelerometer tab
- Comms (Errors) tab
- Map tab
- Workout tab
- Safety tab
- Medic tab
- Map Window

Setup Screens
- Add subject & details
- Set ROG thresholds
- Add & Assign hardware
- Create Teams
- Deploy Teams

Workout Tab
- Display Training BioGauges
- Show current and next Training Zone color

Toolbar
- Add subject to Medic tab
- Live or Setup Screens
- Turn recording ON (default) or OFF
- Notification area
- Set Session name or Workout
- Label & add Markers to recorded sessions
- Display Map Window
- Demo Mode
- Settings dialogue for all configurations
- Help window

Refer to the Live Training > Database Setup & Live Operations modules
Settings

Settings are accessed using the toolbar button.

- **General Settings**
  - Radio Network Type/Mode
  - Imperial/Metric Units
  - System Settings
  - Medic Tab criteria
- **Markers** – Create and manage markers in OmniSense Live for display in OmniSense Analysis graphs
- **Session Names** – Create session names for ease of filtering to access data in Analysis
- **Gauge Settings** – configure fields in BioGauge and Training BioGauge
- **Safety Thresholds** – configure default ROG algorithm thresholds
- **Intensity & Load** – set the Heart Rate & Activity Level ranges over which Intensity & Load are calculated
- **Training Thresholds** – set Physical & Mechanical Load targets. Values will flash in BioGauges when they have been achieved
- **Training Zones** – set color coding of Training BioGauges, by %HR@AT
- **Speed Zones** – set speed zones for indication in Reports in OmniSense Analysis
- **Workouts** – select Workouts from the Robbins Periodization system
Setup Screens

Setup is entered by a toolbar button. Setup screens are accessed by tabs below each screen. Setup populates the OmniSense database for both the Live & Analysis modules.

Subjects
- Name, age, gender, height & weight
- Duplicate names are not allowed
- Fitness Level
- Max Heart Rate
- A variety of HR and BR thresholds to configure the subject Red / Orange / Green algorithm
- Some fitness parameters can be updated automatically using Fitness Test analysis

Teams
- Create and Populate Teams for display on the 4 Team tabs
- Minimum Team size 1 subject
- Maximum Team size 16 subjects
- BioGauges will auto-size

Hardware
- Set Garment Type
- Add, Edit, Remove and Assign BioModules and GPS devices
- Add BioModules by USB, GPS by Bluetooth
- A BioModule can be assigned to more than one subject, if they are not deployed simultaneously

Deployment
- Deploy Teams to Live mode

Refer to the Live Training > Database Setup module
Barcode Deployment

Preparation: Subjects, BioModules, GPS Units & Teams must be added to the database using the Setup screens.

Scan a pick list of devices, subjects and teams for immediate assignment, or ID tags and barcoded devices. Print pick list from OmniSense Live.

Start barcode operation or go to Live mode by scanning a barcode on the pick list.

Refer to the Live Training – Live Operations module
Live Screen

- BioGauges will autoscale to size, dependent on Team size.
- Up to 50, 64 or 100 BioGauges can display, dependent on radio network. (A large monitor will be necessary for larger number of gauges)
- Team tabs will color to show highest ROG level e.g. Red if *any* subject is red.
- Notification area is accessed from the Toolbar and shows system messages.
- Data from the selected BioGauge (yellow outline) will show in the side panels.

Refer to the *Live Training – Live Operations* module.
## BioGauge

<table>
<thead>
<tr>
<th>Impact 0.88</th>
<th>5 configurable fields</th>
<th>Radio Signal Strength</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Color-coding" /></td>
<td>Color-coded sweep scales for BR &amp; HR</td>
<td><img src="image" alt="Signal Strength" /></td>
</tr>
<tr>
<td><img src="image" alt="Medic Tab" /></td>
<td>Medic tab indication</td>
<td>099 BioModule #</td>
</tr>
<tr>
<td><img src="image" alt="Orientation" /></td>
<td>Orientation &amp; Activity Level</td>
<td>R1 Minutes in current ROG state</td>
</tr>
<tr>
<td><img src="image" alt="Battery" /></td>
<td>BioModule Battery Level</td>
<td></td>
</tr>
</tbody>
</table>

Refer to the *Live Training – Live Operations* module
Details Tab

Details & graphs shown for selected BioGauge.
Latest parameters over epoch supported
[1 / 2.5 / 5 seconds]
- HR & BR
- Radio Signal Strength
- HR Confidence – should be > 25% for valid data
- Estimated Core Temperature
- Activity Level
- Posture - 0° = vertical, negative = backward lean
- BioModule Battery

Trend Graphs
- ROG Status
- HR
- BR
- Activity Level
- Estimated Core Temp
- Blood Pressure if sensor enabled
- Blood oxygen if sensor enabled
- Set graph interval at 5 / 10 / 60 minutes

Refer to the Live Training – Live Operations module
Accel Tab

Use button to enable accelerometer data for selected BioGauge. Data can viewed for a single subject only.

- 50 Hz 3-axis data
- Min/Max in previous 1 s epoch
- Jump duration and g if detected (Stationary jump with dip & pause)
- Explosiveness g if detected (sprint start with dip & pause)
- Streaming graphs with mouse cursor display
- Valid on selected Radio Network types only

Refer to the Live Training – Live Operations module
Comms Tab

The Comms tab shows communication status and indicates errors on a system diagram.

Subject Status
- **Valid data – status Green**
- **Valid data – status Orange**
- **Valid data – status Red**
- **Device not worn**
- **Waiting on data**
- **No data received**

- **No Gateway detected – check PC connection**
- **No signal – check device on**
- **Not worn – moisten strap**

Refer to the *Live Training – Live Operations* module
Map Tab

Map tab show geolocation in Latitude & Longitude

A Toolbar button will activate a separate Map window (Internet connection & Google Earth install required) which will display an active, configurable snail trail.

Snail trail will be colored according to sliders adjusted next to the map, to show:
- Heart Rate
- %HR max
- %HR@AT
- Physiological Intensity
- Mechanical Intensity
- Speed Zones
- Altitude Zones
- ROG Safety Thresholds

Colors will match those configured in Live > Preferences

Refer to the Live Training – Live Operations module
Medic Tab

The Medic tab is used to show the BioGauges for any subject whose Status is or has shown Red during a session.

Any subject with an ROG status of Red which persists beyond 30 seconds (configurable in Settings) will display in the Medic tab.

Their BioGauge will display at center.

They will continue to display in the Medic tab – even when Status is no longer Red – until removed manually using the toolbar button.

Refer to the Live Training – Live Operations module
The Safety tab displays ROG status *only for all* (up to 100, dependant on radio network type) subjects in the system. This provides an at-a-glance overview of ROG status for all Teams.

Select any subject BioGauge to return to the Team tab of that subject, to see the subject’s vital signs data.

Refer to the *Live Training – Live Operations* module
Training Tab

- Use in conjunction with the Workout tab.
- Training tab will display Training BioGauges for every subject in the system.
- Training BioGauges are color-coded according to ranges set in Settings > Training Zones.
- The three numeric fields are configurable in Live > Settings > Gauge Settings.
- Color zone ranges are set as percentages of HR at AT, or of Maximum HR.
- Colors are individualized for each subject, according to the values stored for each in the OmniSense database.

The display allows a coach or trainer to oversee the level of effort being achieved by each subject during a group training exercise, so that they can be advised on their performance.

Refer to the Live Training – Live Operations module.
Workout Tab

- Use in conjunction with the Training tab
- Workouts are initiated by selecting a Workout from the list available. Circuit 46 shows above. This list can be populated in the Settings > Workouts dialogue.
- Start a Workout using the toolbar button.
- Workout files are retained in the C:\Users\...\My Documents\OmniSense\WorkoutFiles directory. The pre-loaded Workout files are based on the Robbins Periodization system.
- The current Workout target is displayed, and subjects should strive to reach the target effort level and maintain it for the required period.
- A clock display counts down the remaining minutes and seconds.

Refer to the Live Training – Live Operations module
Baseline Fitness Testing

Ramped fitness Tests - either a Treadmill Test or a Beep Test – are used to establish baseline levels of fitness such as

- Maximum Heart Rate (HR\textsubscript{max})
- Heart Rate at Anaerobic Threshold (HR@AT)
- Heart Rate Recovery (HRR)

If a fitness test is recorded in OmniSense Live, then the data can be retrieved in OmniSense Analysis, and analysed automatically or manually.

Fitness parameters can then be saved into the OmniSense database, and used as metrics in subsequent Fitness Reports for that subject.

Refer to the Live Training > Baseline Fitness Testing module
Live Operations
Preparation

The following steps must be performed prior to going Live:

1. Add Subjects to database
2. Add BioModules and GPS devices (if used) to database

These tasks must be performed manually using the setup screens and Add Hardware Wizards

3. Assign components to subject
4. Add subject to team
5. Deploy Team

Manually using setup screens, or using the Barcode Rapid Deployment Tool. Start the Tool from the Setup > Subject tab.

Radio Network Type should be set in Settings > General Settings to ECHO

Refer to the Live Training – Live Operations module
Issue Components

Issue BioModules to appropriate subjects
- Scan with Barcode scanner or
- Check on screen in Setup > Hardware or
- Check against allocation list

The BioModule must be issued as assigned; otherwise data will be saved to the wrong record in the OmniSense database

Power ON BioModule
- Press BioModule center till LEDs light
- To power OFF, press and hold till all LEDs flash then extinguish

LED Behaviour

<table>
<thead>
<tr>
<th></th>
<th>Constant</th>
<th>Flashing</th>
<th>Unlit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Blue</td>
<td>Error</td>
<td>Transmitting</td>
<td>Transmit not configured</td>
</tr>
<tr>
<td>Orange</td>
<td>&gt;30% Battery</td>
<td>Transmitting, &lt; 30% battery</td>
<td>&gt; 10% battery</td>
</tr>
<tr>
<td>Red</td>
<td>Strap worn, no heart rate detected</td>
<td>Heart Rate Detected</td>
<td>Not worn</td>
</tr>
<tr>
<td>Green</td>
<td>Error</td>
<td>Logging</td>
<td>Logging not configured</td>
</tr>
</tbody>
</table>

See section on logging for LED behaviour in charge case/cradle

Fit to strap
Moisten grey sensor pads with water
Fasten at front, adjust tension and rotate into position
Strap Fitting

- Tension indication loop at rear should be flush with strap when subject inhales and chest is fully expanded.
- Show un-tensioned here.

- Center of BioModule directly under armpit.
- For optimum breathing detection BioModule should be at apex of rib curvature.
- The BioModule can be located slightly (~ 1”) to the rear only (dotted line) if the optimum position is uncomfortable.

Refer to the Live Training – Live Operations module
Repeater Location

- For best coverage, place a repeater at each corner of the training area.
- Repeaters communicate directly with the Gateway, but not with each other.
- Maximum range with a repeater is doubled from 300 to 600 yards.
- Best location diagrams can be found on the rear of each repeater.
Startup Sequence

- Locate and power ON any field repeater units being used
- Power on the internal Power pack or connect the USB connector to an external USB power source
- Connect Gateway to PC
- Power ON BioModules
- Power ON GPS if used
- Start OmniSense Live

BioModule clocks are synchronized
GPS addresses are sent to BioModules

Status sequence:
- Black - Communicating with BioModule
- Green / Orange /Red – valid data
- [Grey – not worn; wet strap sensor pads]
- [Blue – Comms error – check Comms tab]
After Live mode is selected:
- BioModule clocks are synchronized
- GPS addresses are sent to BioModules
- Wait 1 – 2 minutes for network connections to establish and stabilize.
- Status indication may switch between colors intermittently.

Data Stabilization times:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Heart Rate:</td>
<td>5 seconds</td>
</tr>
<tr>
<td>Breathing Rate:</td>
<td>30 – 45 seconds</td>
</tr>
<tr>
<td>Core Temperature:</td>
<td>1 second</td>
</tr>
<tr>
<td>Activity/Posture:</td>
<td>1 second</td>
</tr>
</tbody>
</table>

Refer to the Live Training – Live Operations module
Pebble Watch & Zephyr Watch Application
- Watch supports BioModule with Bluetooth Low Energy (BH3-BLE).
- Zephyr Watch App is preloaded when the watch is shipped.
- The Watch App operates independently of OmniSense.
- Three customizable fields on screen:
  - Hear Rate, Respiration Rate, Training Zone, Estimated Core Temperature, Posture, Activity Level, Heart Rate Variability (after 300 beats), Stress Level (1 – 10)
- Update rate 1 / 5 / 10 / 15 / 20 / 25 / 30 / 35 / 40 / 45 / 50 / 55 / 60 seconds

Refer to the *Live Training – Pebble Watch & Application* module
OmniSense Analysis
Overview

Filter Sessions by:
- Team, Subject
- Session Name
- Subsession Name
- Time / Date

Manage Sessions
- Export, rename, move, delete & archive

Legend:
- Compare up to 16 color-coded sessions simultaneously

Export Graph Data
- Multiple file & image formats

Time Graphs
- Show 2 parameters from 46 available
- Automatic & Manual Fitness Testing analysis
- Show real or elapsed time
- ROG Status or Training Zone background colors
- Create subsessions to eliminate unwanted data

Summary Graphs
- Show 2 parameters from 45 available
- Min, Avg or Max as histograms

Fitness & Training Reports
- Compare individual against Normative data
- Mean, Standard Deviation
- Compare Individual against Team data
- Table and Radar Plot format
- Group Consolidated Summary
- Periodization Report
- Summary GPS
- Summary Physiological
- Workout Compliance

Impact Reports
- 5 configurable Impact zones by g force
- Based on 100Hz 3-axis data
- Summary counts per zone
- Magnitude, duration & direction of impacts
- Automatic grouping of impacts by type
  - Walk
  - Run / Intense run
  - Bound, jump
- Detailed analysis showing peak g, rise time, duration, rate of force development & decline, total impulse load
Physiological Parameters

The following parameters are available *in addition* to those displayed in OmniSense Live

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>From Fitness Test Analysis</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HR @ AT</td>
<td>Beats/minute</td>
<td>From detection of Anaerobic Threshold</td>
</tr>
<tr>
<td>BR @ AT</td>
<td>Breaths/minute</td>
<td>From detection of Anaerobic Threshold</td>
</tr>
<tr>
<td>VO$_{2\max}$</td>
<td>ml/kg/min</td>
<td>Based on Heart &amp; breathing rates</td>
</tr>
<tr>
<td>HR$_{\max}$</td>
<td>Beats/minute</td>
<td>Maximum heart rate of subject</td>
</tr>
<tr>
<td>BR$_{\max}$</td>
<td>Breaths/minute</td>
<td>Maximum breathing rate of subject</td>
</tr>
<tr>
<td>Heart Rate Recovery</td>
<td>Beats per 30 sec</td>
<td>On cessation of test, stationary subject</td>
</tr>
<tr>
<td>%VO$_{2\max}$ @ AT</td>
<td>%VO$_{2\max}$</td>
<td>Accepted performance indicator</td>
</tr>
<tr>
<td>Fitness Level</td>
<td>Scale 1 - 10</td>
<td>10 = elite athlete</td>
</tr>
<tr>
<td><strong>From Summary Graphs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max, Min, Average</td>
<td>All parameters</td>
<td></td>
</tr>
<tr>
<td>Speed</td>
<td>Box Plot</td>
<td>2nd, 9th, 25th, 50th, 75th, 91st, 98th, 100th percentiles</td>
</tr>
<tr>
<td>Elevation</td>
<td>Box Plot</td>
<td>2nd, 9th, 25th, 50th, 75th, 91st, 98th, 100th percentiles</td>
</tr>
<tr>
<td>Jump time in air</td>
<td>Seconds</td>
<td>Based on jump detection</td>
</tr>
<tr>
<td>Jump height</td>
<td>Feet / meters</td>
<td>Based on jump detection</td>
</tr>
<tr>
<td>Exercise Time</td>
<td>Duration</td>
<td></td>
</tr>
<tr>
<td>Time above AT</td>
<td>Duration</td>
<td></td>
</tr>
<tr>
<td>Time in HR Zones</td>
<td>% Total Duration</td>
<td>Banded histogram - % time in each zone</td>
</tr>
<tr>
<td>Time in Training Zones</td>
<td>% Total Duration</td>
<td>Banded histogram - % time in each zone</td>
</tr>
<tr>
<td>Time in Speed Zones</td>
<td>% Total Duration</td>
<td>Banded histogram - % time in each zone</td>
</tr>
<tr>
<td>Distance in Speed Zone</td>
<td>% Total Distance</td>
<td>Banded histogram - % time in each zone</td>
</tr>
<tr>
<td><strong>From Reports</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average Value</td>
<td>Of all parameters in report</td>
<td></td>
</tr>
<tr>
<td>Standard Deviation</td>
<td>Of all parameters in report</td>
<td></td>
</tr>
<tr>
<td>Significantly Low Value</td>
<td>Less than 1 STDDEV below average</td>
<td></td>
</tr>
<tr>
<td>Significantly High value</td>
<td>More than 1 STDDEV above average</td>
<td></td>
</tr>
<tr>
<td>% Time in HR Zones</td>
<td>% Total Time</td>
<td>Time in various zones</td>
</tr>
<tr>
<td>% Time &gt; HR@AT</td>
<td>% Total Time</td>
<td>Time operating above Anaerobic Threshold (AT)</td>
</tr>
<tr>
<td>% Time &lt; HR@AT</td>
<td>% Total Time</td>
<td>Time operating below AT</td>
</tr>
<tr>
<td>Peak HR</td>
<td>Beats/minute</td>
<td>For the session</td>
</tr>
<tr>
<td>Average HR</td>
<td>Beats/minute</td>
<td>For the session</td>
</tr>
<tr>
<td>Average, Max HRV</td>
<td>ms (STDDEV)</td>
<td>Average, Max in milliseconds 300 beat SDNN values</td>
</tr>
<tr>
<td>Average, Max HRR</td>
<td>Beats in 30 seconds</td>
<td>If stationary 30 second intervals detected</td>
</tr>
<tr>
<td>Average, Max Core Temp</td>
<td>Degrees C / F</td>
<td>For the session</td>
</tr>
<tr>
<td>Time in Training Zones</td>
<td>Duration</td>
<td>Blue/Green/Yellow/Orange/Red zones</td>
</tr>
<tr>
<td>Time in Speed Zones</td>
<td>Duration</td>
<td>Purple/Blue/Green/Yellow/Orange/Red zones</td>
</tr>
<tr>
<td>Distance</td>
<td>Miles/km</td>
<td>Distance in above zones</td>
</tr>
<tr>
<td>Average, Max Speed</td>
<td>Miles or km per hour</td>
<td>For session</td>
</tr>
<tr>
<td>Elevation Climb, Descent</td>
<td>Feet / meters</td>
<td>Total climb &amp; descent for session</td>
</tr>
</tbody>
</table>
Workflow

Suggested workflow:

1. Select graph type: for Time graph, for Summary graph, for report type

2. Filter sessions using pulldowns (default All, current date). A unique Session Name created when recording in OmniSense Live will make for easiest filtering.

3. Transfer sessions from the filtered Select Session tree to Reports or Legend for graph display by drag and drop, double-click, or context menu:

4. Select Variables to be displayed
   • First selection >> Left vertical axis, solid trace
   • Second selection >> right vertical axis, dashed trace
   • Treadmill & Beep Tests show three traces

Refer to the Analysis Training > Overview module
Time Graphs

Vertical Axes
- Left axis – 1st variable selected
- Right axis – 2nd variable selected

Horizontal Axis
- Real time – Sessions may not align
- Elapsed Time - all sessions start 00:00:00

Cursor Location – drag cursor to show data values + Real & Elapsed Time

Background Shading
- ROG status
- Training Zone (HR)
- Speed Zone (GPS)
- Positional Error

Refer to the Analysis Training > Overview module
### Time Graph Operations

<table>
<thead>
<tr>
<th>Subsessions</th>
<th>Drag mouse cursor to select, and name. Use to eliminate unwanted data.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full screen</td>
<td>Show graph area full screen</td>
</tr>
<tr>
<td>Print</td>
<td>Display Print Dialogue</td>
</tr>
<tr>
<td>Clear Data</td>
<td>Clear all data from Legend and Graph area</td>
</tr>
<tr>
<td>Zoom In</td>
<td>Drag a rectangle in direction shown to zoom in. Axes will auto-scale</td>
</tr>
<tr>
<td>Zoom Out</td>
<td>Drag a rectangle (any size) in the opposite direction to zoom out</td>
</tr>
<tr>
<td>Pan</td>
<td>Right-click, hold and drag graph to move in any direction</td>
</tr>
</tbody>
</table>

Refer to the Analysis Training > Graph Options module
Select the Treadmill Test or Beep Test variables to display Heart Rate, Breathing Rate & Activity Level. Use the buttons to automatically or manually detect fitness parameters and save them to the OmniSense database.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Detect</strong></td>
<td>Auto-detect start and end of test, AT threshold, maximum HR and HRR phase.</td>
</tr>
<tr>
<td><strong>AT</strong></td>
<td>Use cursor and manually set location of anaerobic threshold – increase in breathing rate.</td>
</tr>
<tr>
<td><strong>Start</strong></td>
<td>Set the start of the Test, for calculation of VO$<em>2$$</em>{\text{max}}$ by formula.</td>
</tr>
<tr>
<td><strong>Save</strong></td>
<td>Save selected parameters to the OmniSense database for use in reports and in setting training zones for future use.</td>
</tr>
<tr>
<td><strong>HRR</strong></td>
<td>Set heart rate recovery phase – 30 seconds of inactivity at the start of the test.</td>
</tr>
<tr>
<td><strong>End</strong></td>
<td>Set the end of the Test, for calculation of VO$<em>2$$</em>{\text{max}}$ by formula.</td>
</tr>
</tbody>
</table>

Refer to the Analysis Training –Fitness Testing Analysis module
Summary Graphs

**Vertical Axes**
- Left axis – 1st variable selected
- Right axis – 2nd variable selected

**Horizontal Axis**
- Labelled A – P as per Legend entries

**Column Headings**
- Show the maximum value, in the absence of a cursor

<table>
<thead>
<tr>
<th>Full screen</th>
<th>Show graph area full screen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Print</td>
<td>Display Print Dialogue</td>
</tr>
<tr>
<td>Clear Data</td>
<td>Clear all data from Legend and Graph area</td>
</tr>
</tbody>
</table>
Reports
Training Reports Overview
Multiple sessions are added to a training report. Tables and radar plots are created, comparing individual subjects to the mean, lower and upper values (one standard deviation above and below the mean) for the group.

1. Filter the sessions needed for the report in the Filter Session list, and select the Training Reports tab in the graph panel.

2. Right-click on a session and select Copy Sessions To > Training Reports from the context menu.

3. When the reports panel is populated, use the button to select report type
   - Group Consolidated (all parameters)
   - Periodization (Intensity & Load)
   - Summary GPS (Time & Distance in speed zones, Avg & Max speed)
   - Summary Physiological (HR, HR@AT, HRV, HRR, Core Temp & Calories)
   - Workout Compliance (Load & Intensity, Time in Training Zones)

Refer to the Analysis Training > Reports module
A multi-tab spreadsheet is created.

- **SessionSummary Tab** – Group Data – Mean, high and low values for each parameter. Thresholds are ± 1 Standard Deviation
  - Time in 65/85% HR Zones
  - Peak/Avg. HRV
  - Calories Burned
  - Time in Speed Zones
  - Total Climb/descent
  - Time above/below AT
  - Peak/Avg. HRR
  - Load & Intensity
  - Dist. In Speed Zones
  - Peak/Avg. Core Temp
  - Time in Training Zones
  - Peak/Avg. Speed

- **Subject Tab** – all individual values above, plus a radar plot
  - All axes normalized
  - Blue core shows Group mean values
  - Red polygon shows subject values for comparison
  - Export report and delete columns to remove unwanted axes (e.g. all GPS data in example above)
Periodization – Intensity & Load Parameters

A multi-tab spreadsheet is created.

- **Session Summary Tab** – Group Data – Mean, high and low values for each parameter. Thresholds are ± 1 Standard Deviation
  - Physiological Intensity – on a scale of 1 – 10, Range configurable in OmniSense Live > Settings. Default 0=50% HR$_{max}$, 10=100% HR$_{max}$
  - Physiological Load = Cumulation of Physiological Intensities
  - Mechanical Intensity – on a scale of 1 – 10, Range configurable in OmniSense Live > Settings. Default 0=0.5g, 10=3g
  - Training Intensity = Average of Physiological + Mechanical intensities
  - Training Load = Average of Physiological + Mechanical Loads
  - Sessions are grouped and summarized by Periodization session name e.g, Circuit 46, High Intensity 37.

- **Subject Tab** – Load and Intensity Summary histograms, showing calendar progression of session summaries.

Refer to the Analysis Training > Reports module
GPS – Speed, Distance & Elevation Parameters

A supported GPS must be used in conjunction with the BioHarness.

A multi-tab spreadsheet is created.

- **Session Summary Tab – Group Data** – Mean, high and low values for each parameter. Thresholds are ± 1 Standard Deviation
  - Time in Speed Zones 1 – 6, configured in OmniSense Live > Settings
  - Distance in Speed Zones 1 – 6, configured in OmniSense Live > Settings
  - Avg./Max Speed
  - Total Elevation climbed/descended
  - Total Distance Travelled

- **Subject Tab** – all individual values above, plus a radar plot
  - All axes normalized
  - Blue core shows Group mean values
  - Red polygon shows subject values for comparison

Refer to the **Analysis Training > Reports** module
Workout Compliance – Intensity, Load & Training Zone Parameters

A multi-tab spreadsheet is created.

- **Session Summary Tab** – Group Data – Mean, high and low values for each parameter.
  - Thresholds are ± 1 Standard Deviation
  - Physiological Intensity – on a scale of 1 – 10, Range configurable in OmniSense Live > Settings. Default 0=50% HR_{max}, 10=100% HR_{max}
  - Physiological Load = Cumulation of Physiological Intensities
  - Mechanical Intensity – on a scale of 1 – 10, Range configurable in OmniSense Live > Settings. Default 0=0.5g, 10=3g
  - Training Intensity = Average of Physiological + Mechanical intensities
  - Training Load = Average of Physiological + Mechanical Loads
  - Time in Training Zones, as configured in OmniSense Live > Settings

- **Subject Tab** – all individual values above, plus a radar plot
  - All axes normalized
  - Blue core shows Group mean values
  - Red polygon shows subject values for comparison

Refer to the *Analysis Training > Reports* module
BioModules are configured to log all transmitted data internally by default.

When the device memory is full, old logs will be overwritten with the current log.

Logging formats are configurable using the Zephyr Config Tool. If ECG and Accelerometry Waveforms are logged in addition to the default 1Hz data, logs will take very much longer to download.

To Download logs from the device, use the Zephyr Downloader Tool in OmniSense Analysis, accessed by the button. Choose the From BH option.

Dependent on Options selected from the menu, the Downloader will automatically download any log sessions not yet downloaded, and assign them to the subject currently assigned that BioModule in the database. Download can be by USB connection, or over Bluetooth.

All download settings can be over-ridden manually

Logs can be imported into the OmniSense database for access by OmniSense Analysis and/or exported to external .csv files for access by other tools

Refer to the Analysis Training > Log Data module
Impact Analysis
Impact Analysis is performed using 100Hz 3-axis accelerometer data logged in the BioModule.

To acquire this data, the BioModule’s default ‘Summary’ log format must be reconfigured to ‘Summary and Waveform’ using the Zephyr Config Tool.

Logs are downloaded using the Zephyr Downloader.

Start the Impact Processor using the button in OmniSense Analysis.

The Processor will check for any Accelerometer waveform filers not yet processed.

An AccelPro Impact Report file is generated in the same location as the original waveform file in the ...\Documents\BioHarness Test Logs directory.

The AccelPro report is an Excel Spreadsheet with 3 tabs:

- Summary – all impulse detections are categorized into types, dependent on g range (configured in the Edit menu of the tool). Types include walk, run, bound, jump as well as collision impacts.
- Data Line tab displays all detected impulses, type, summary data and a hyperlink to detailed accelerometer stream.
- Accelerometry Stream displays the 100Hz 3-axis data visually, with magnitude, force and impact angle data.

Refer to the Analysis Training > Impacts module.
Readiness
A Zephyr proprietary algorithm will calculate a Readiness metric on a 1 – 10 scale (10 = optimally ready) based on:

- Data from an orthostatic hypotension test to gather
  - Resting heart rate
  - Resting heart rate variability
  - Standing Heart Rate
- Subjective data from a survey completed by the subject, who rates on a 1 -10 scale their
  - 10-day average training load
  - 10-day average training intensity
  - Sleep quality
  - Overall stress
  - Current stress
  - Eating habits
  - Hydration level
  - Injury state

OmniSense Analysis will automatically analyse orthostatic test data gather in Live, or logged on a BioModule.

A history time or summary graph of all of the above components can be displayed in Analysis.

A future implementation will allow test data and survey answers to be recorded in an Android application which will email results to a recipient for entry to the OmniSense database.

Refer to the Analysis Training > Readiness module
Manage Data
Right-click on any session or sessions in the Select Session tree to display a context menu offering multiple session management options:

- Rename a session. The timestamp is retained.
- Export to .ZSF (Zephyr Serial File). The session can be re-imported at any stage, or imported into another instance of OmniSense Analysis on another PC.
- Export to kml. If a session has GPS data embedded, a kml file is generated which will display on Google Earth along with vital signs.
- Archive - .ZSF files are created of sessions, and the sessions themselves are deleted from the database. This can help declutter the database, reduce its size and speed up access time.
- Delete sessions permanently if the data is no longer needed.
- Delete all sessions displayed in the Select Session panel.
- Copy sessions to the Legend for Graph display, or into Reports.
- Create subsessions – divide a longer session into components, or trim unwanted data at the beginning and end of a session.
- Move a session to another person, if it has been wrongly assigned.
- Merge Sessions – useful when merging logged data and live data from the same session.
- Change the timestamp of a session.
- If data has been filtered in a session, save a filtered version of the session. The original is retained.

Refer to the Analysis Training > Overview module.
Utilities
All utilities can be accessed from
Windows Start Menu > All Programs > Zephyr > OmniSense Tools

Zephyr Config Tool

Use the config tool or change the settings of one or multiple devices. The major settings are:

- Bluetooth
  - Turn Bluetooth ON/OFF. Legacy settings for older systems.
- Polling
  - Legacy settings.
- Subject Info
  - Legacy settings for ROG status algorithm.
- User Config
  - Turn Logging mode ON/OFF.
  - Set logging format.
  - Turn transmit ON/OFF.
- Time
  - Synch the device clock.
- Accelerometer
  - Configure the device appropriate to the garment it is being used with.
- ECHO
  - Set the unique ECHO short address for the device.

Refer to the Analysis Training – Software Utilities module
Zephyr Updater

- Update BioModule firmware with .img firmware files. Latest version firmware image files are shipped with each version of OmniSense. A firmware versions document is included.

Refer to the Analysis Training – Software Utilities module
BioHarness Log Downloader

- The Log Downloader is a legacy tool which will display and download BioModule log files as external .csv files.

- It does not import log files into the OmniSense Database.

- A full set of log file parameters can be found in the document *BioHarness Log Data Descriptions* included on the OmniSense CD or download.

Refer to the *Analysis Training – Software Utilities* module
Kubios Converter

Kubios is a tool used to perform detailed HRV Analysis. It has been created by the University of East Finland and is available at [http://kubios.uef.fi/](http://kubios.uef.fi/) as a free download, though registration is necessary.

- The input files for Kubios are .txt files simply showing RR intervals in seconds.
- The Zephyr Kubios converter tool will take any Zephyr external .csv file of RR data, and convert it into a text file for use with Kubios.
- The external .csv RR files must be generated using the BioHarness Log Downloader, or the Zephyr Download available from the Analysis toolbar, with Menu > Options > Write CSV Format Log Files option checked.
- You cannot use the Converter on a file which has been exported from Analysis itself.
- The Kubios Application User’s Guide is downloadable from the web address above.

Refer to the Analysis Training – Software Utilities module
Data Plotter

- The Data Plotter is a tool which can be used to view external csv files containing large amounts of data, for example ECG waveform files, or 100Hz accelerometer files.

- These files will open by default in Microsoft Excel®, but Excel has a limit of 1,000,000 data points per file. This just over an hour of 250Hz ECG data. Excel graphs have a limit of 32,000 data points, which is 128 seconds of 250Hz ECG.

- This data is not imported into OmniSense Analysis. However, if the BioModule is configured to log Summary and Waveform data using the Zephyr Config Tool, then external csv files can be generated.

- The Tool can view data only. It has simple zoom and pan functions, but performs no analysis and has no export function.

Refer to the Analysis Training – Software Utilities module
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