

Sensory Perception Enhancement Device



Speadtech founded by Peter Hill and acclaimed driver instructor Rob Wilson.

DEVELOPMENT REFERENCE

V1.0

17th December 2020

CONFIDENTIAL

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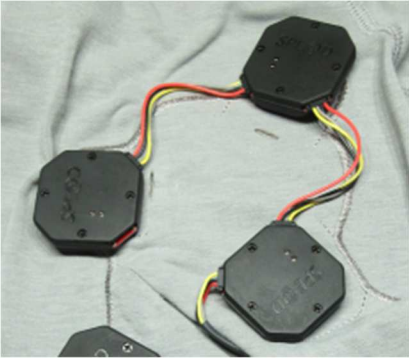
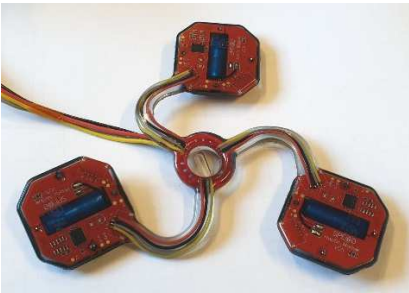
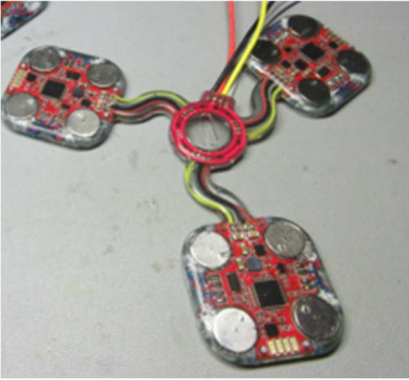
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2 VEST HAPTICS

The table below provide an overview of the vest haptics.

Model	Image	Description
Tiga QuadHap		Hard case. 11.6mm / 15.6mm thick. ERM satellites. Each group of 3 controlled by an additional QuadHap controller.
1 st Generation		10.0mm thick haptic, hard case. Powerful ERM, 23x8.8mm Diameter. Supports flexible arrangement using pluggable wired links.
2 nd Generation		10.0mm thick haptic, soft over-molding. Powerful ERM, 23x8.8mm Diameter. Waterproof. Groups of 3 with robust connector.
3 rd Generation		4.8mm thick haptic, soft over-molding. 4x Coin ERMs. Waterproof. Groups of 6 with robust connector.
4 th Generation	Custom Haptic	Feasibility investigation into developing a custom flat haptic engine.

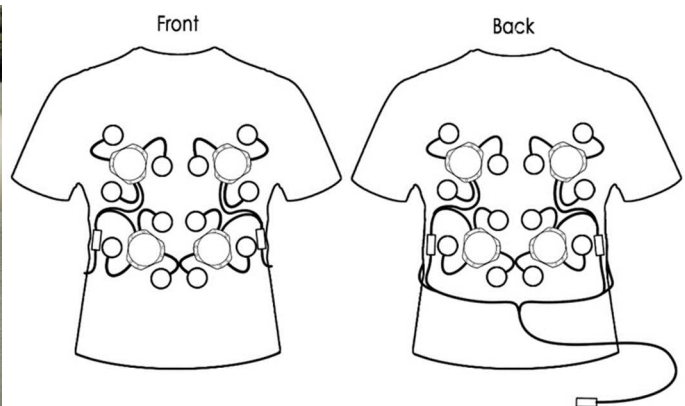
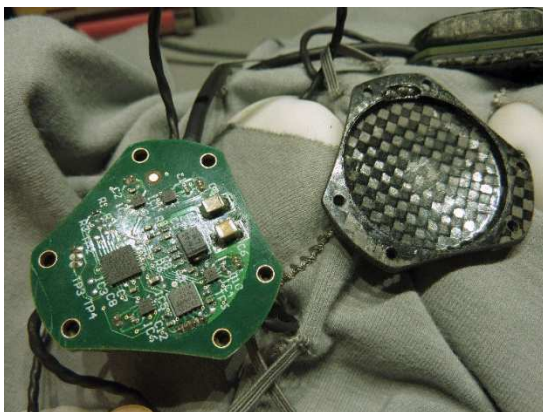
2.1 TIGA QUADHAP



Haptic motor modules with carbon fibre variant.

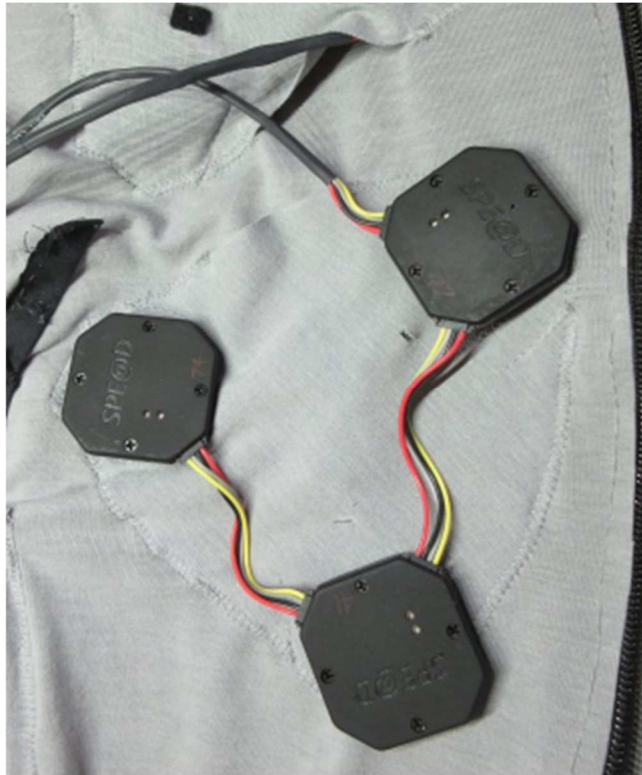


Each group of 3 haptic motor modules controlled by a QuadHap module.

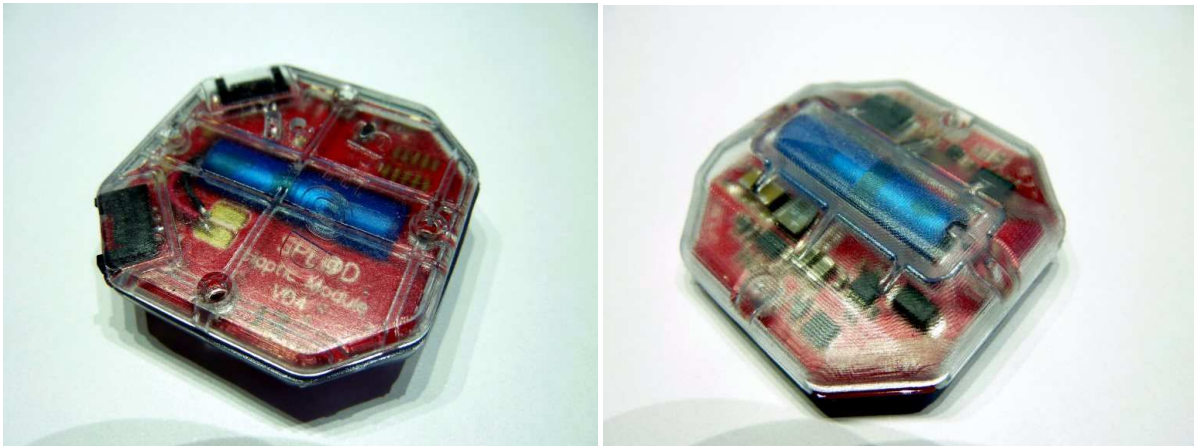


The Vest uses 8 QuadHap modules to drive a total of 24 haptic motors. Vest weight 840g.

2.2 1ST GENERATION HAPTICS



Hard cases. Supports flexible arrangement using pluggable wired links. Most powerful ERM used.



2.2.1 V04 - VESTS 3 & 4



Both long sleeve with zipper. Some wiring exposed. Tested with Alex at Philip Island. Soft felt buttons didn't hold haptics. Needed tighter fit to feel front haptics. Rear haptics uncomfortable, particular upper rear haptics, near arm pits.

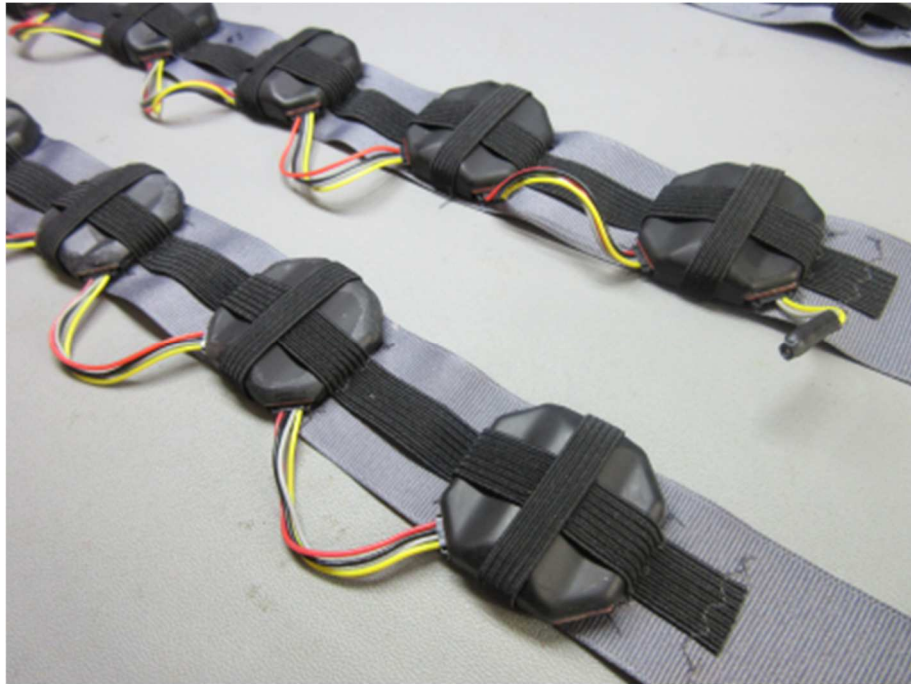
2.2.2 V04 - VESTS 5 & 6



Both long sleeve. Design updated for better haptic retention and cable management.

Used in Abu Dhabi. Haptics on rear were uncomfortable. Garment stretches in the middle for wide shoulder user, which caused discomfort with custom seating.

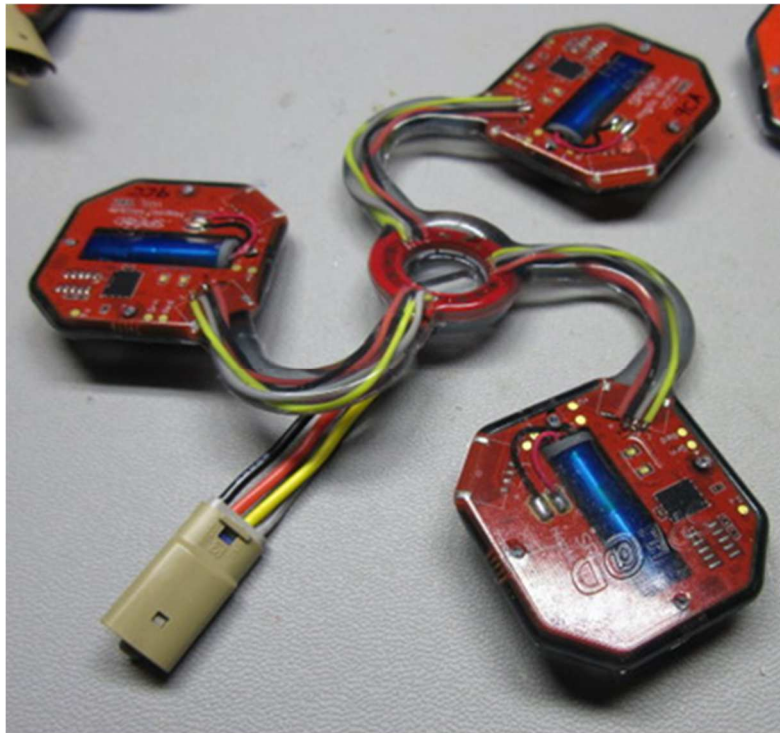
2.2.3 1ST GENERATION - HAPTICS ARRAYS



Used on simulator to test varies configurations for haptics on legs and arms.



2.3 2ND GENERATION HAPTICS - OVER MOLDED



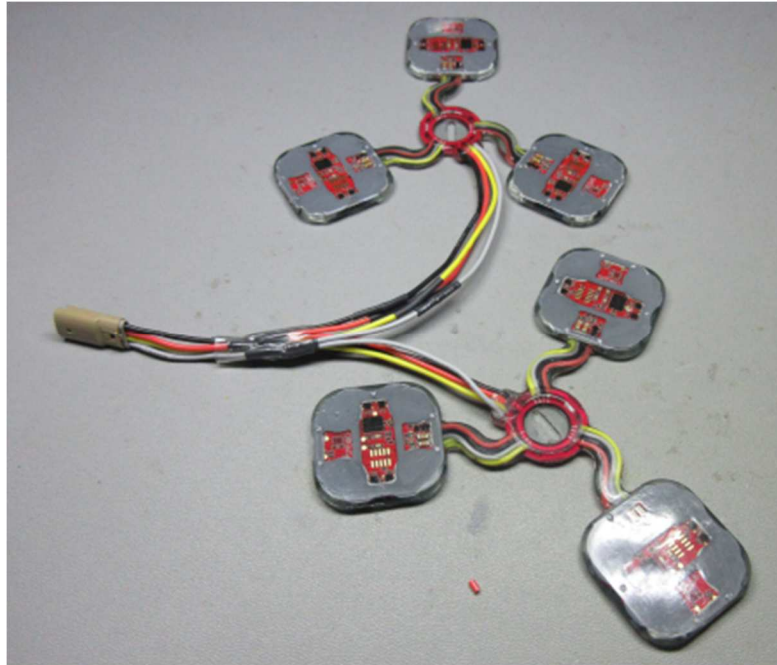
Softer material alternative. Waterproof design.

Fixed arrays of 3 units with low profile robust Molex connectors.

2.4 2ND GENERATION – VESTS



2.5 3RD GENERATION - LOW PROFILE HAPTICS



Integrates 4 coin ERMs. ~4.8mm thick.



One vest produced. Two vests in production.

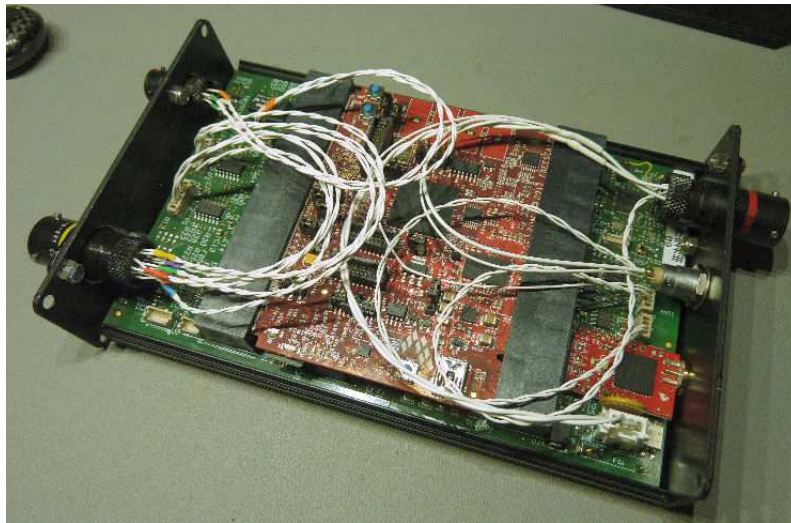
3 VEST INTERFACE MODULE

The table below provide an overview of the current vest controllers. Table excludes previous Tiga controller.

Model	Gen1	Gen2	Gen3	Gen4
Purpose	Development	Testing	Vehicle Testing Compact Format.	Racing Fully integrated design.
MPU	Tablet PC PEAK-CAN interface.	NUC Mini-PC PEAK-CAN interface.	NUC Mini-PC PEAK-CAN interface.	ARM M4 Intel Atom Integrated CAN
Vehicle Wiring	CAN 500kbps	CAN up to 1Mbps Power 6-9A peak	CAN up to 1Mbps Power 6-9A peak	CAN up to 1Mbps Power ~6A peak
Format	Pelican case. Battery powered.	271x170x60mm Fan cooling 0°C to 40°C ~2kg	231x125x60mm Lower profile option with mounting flange ~250x125x43mm. Fan cooling 0°C to 40°C Weight TBA	Dimensions TBA Passive cooling 0°C to 60°C Weight 292g
Vest Compatibility	Developed with Gen 1 Haptics	Gen 1 or Gen 2 Haptic Vest	Gen 2, 3, 4 Haptic Vest	Gen 2, 3, 4 Haptic Vest
Status	Development complete. No longer used.	Active testing format.	Active design focus to support upcoming vehicle testing. To be used as testing platform for ARM M4 and integrated CAN.	Intel Atom platform.

3.1 TIGA TWR ECU

For historic reference, the prior vest controller developed by Tiga is shown below.



165x106x35mm, 472g.

3.2 1ST GENERATION VEST CONTROLLER



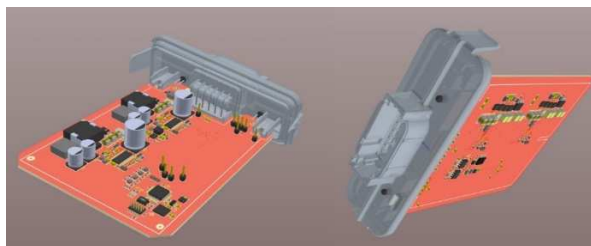
Tablet PC running from lithium-Ion batteries.

3.3 2ND GENERATION VEST CONTROLLER



NUC Mini-PC (113x112x51mm) and an interface box (Deutsch DTM13-12PA enclosure). The interface provided regulated/safe power for the NUC and vest. Future intent to integrate the NUC into the interface module.

Used in Abu Dhabi testing with Porsche RSR.



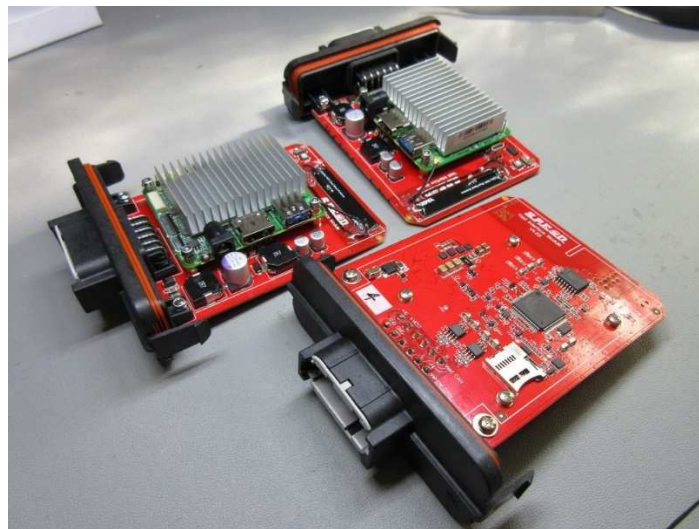
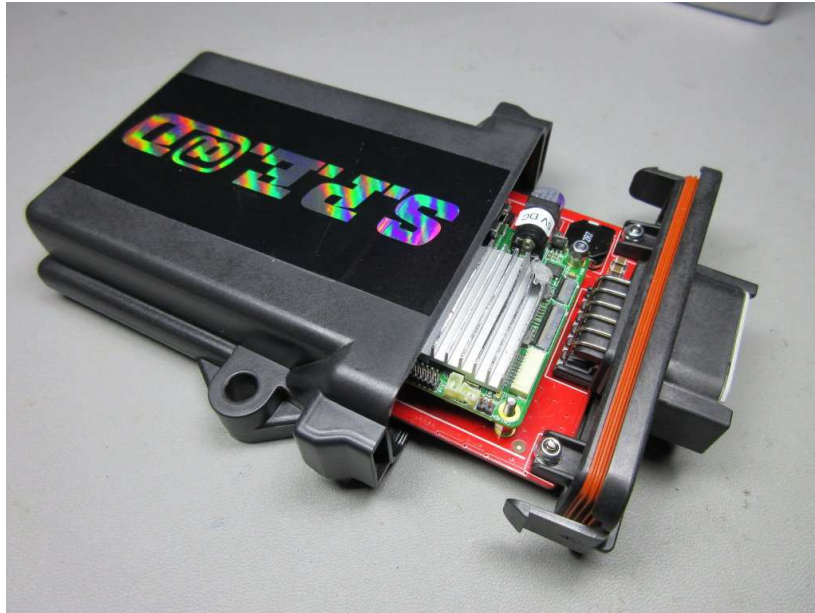
3.4 3RD GENERATION VEST CONTROLLER



Developed for Formula E Simulator testing at Porsche, Germany.

Uses Gen 2 interface for regulated/safe power, NUC and dual PCAN adaptors.

3.5 4TH GENERATION VEST CONTROLLER



Compact vest controller where vehicle data can be provided on a CAN interface.

UP-Core platform with WiFi connectivity for vest control/configuration. ARM Cortex M4 managing vehicle CAN communications.

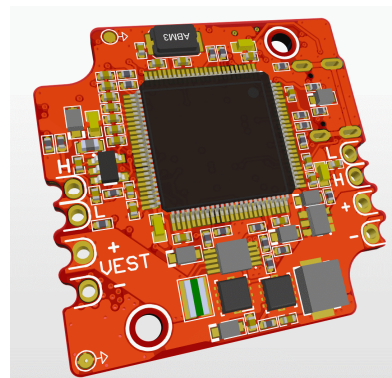
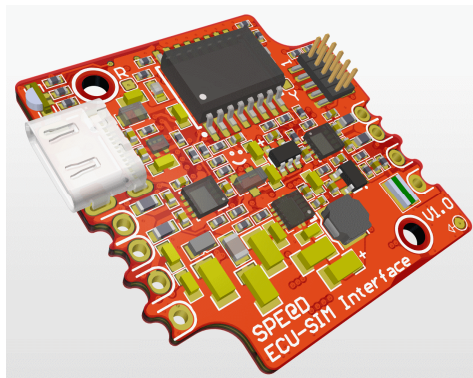
Homologation sample sent to Porsche 20th September 2019.



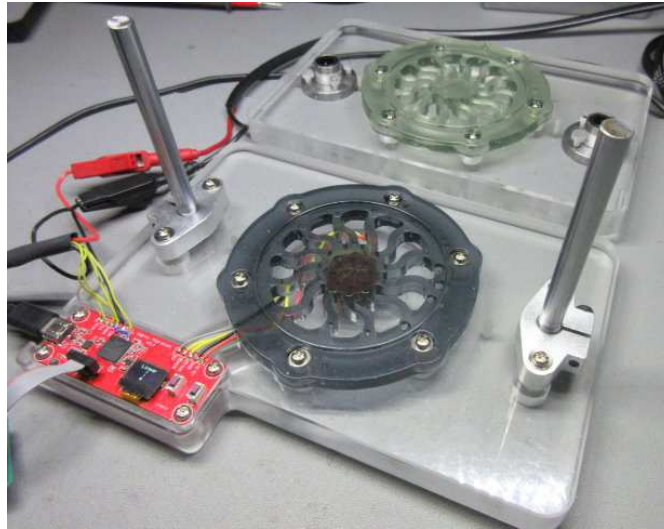
This module is a dual purpose vest interface.

The ECU-SIM interface removes the need for the larger more expensive vest controller for the following setups.

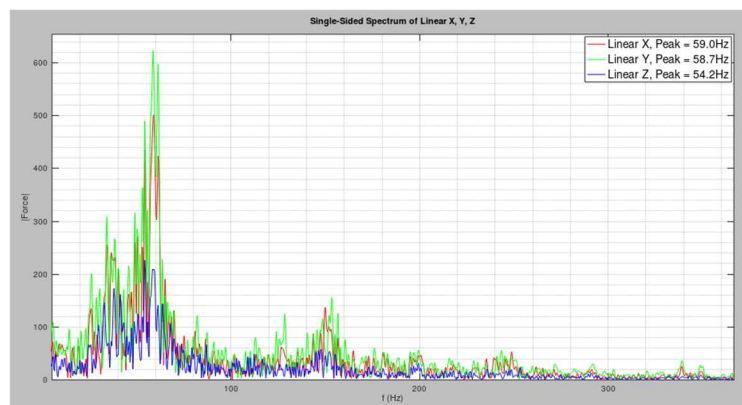
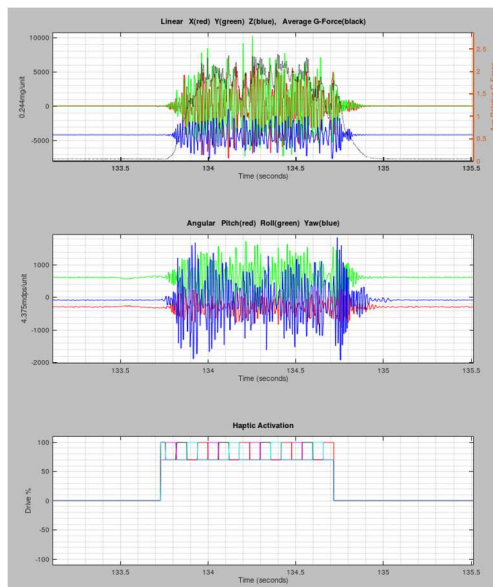
1. Simulator only use. USB connection and vest power supply required.
2. Vest control is integrated into the Maclaren Tech 320 ECU and interfaced via CAN.



5 VIBRATION MEASUREMENT JIG



Vibration measurement jig developed. Jig provides assessment of haptic g-force. Linear and angular acceleration, 6-axis. First used to measure and tune flat haptic ERM disruption algorithm.



The screenshot displays the SPE@D software interface, titled 'SPE@D Vest Driver - Revision 01.003.005'. The main window shows a list of events on the left, including 'RR Wheelslip', 'RL Wheelslip', 'Understeer', 'Front Right Understeer', 'Front Left Understeer', and 'RPM Test'. The 'RR Wheelslip' event is selected, and its configuration is shown in the main area. A dialog box titled 'Creating an Event' is open, providing instructions on how to create an event. The dialog includes a list of available inputs and a table of event types with their descriptions.

Creating an Event
 In order to create an Event to trigger you need three items.

1. A selection of Inputs to use
2. A Trace/Pattern to be 'played' when the event is successful.
3. An Event 'type'

Inputs
 To select the Inputs to be used, select them in the *Inputs List* to the left.
 Note : The inputs available are controlled in the **INPUT LOGIC** → **Input Selection** tab in the main display.

Trace/Pattern
 These are created in their respective Trace and Pattern Tabs in the **OUTPUT LOGIC** main tab. Once created they can be selected from the boxes to the left, at least ONE Pattern or Trace **must** be selected.

Event Type
 The Event Type selection controls how the Trace or Pattern will play.

SINGLE_SHOT	The Haptic sequence will play once then stop
OUTPUT_HOLD	The Haptic sequence will play and then hold the last factors ON
WAVE	The Haptic sequence will treat the entire sequence as a 'wave' that extends from 0.0 – 1.0 and it will continue to play the section of the wave at the required point.
LEVEL	The Haptic sequence will treat the entire sequence as an increasing level that extends from 0.0 – 1.0 and it will continue to play all sections from 0 to the current value. Think if it like a bar chart on an audio amplifier.
PULSE	The Haptic sequence will play then at the end of the sequence, it will pulse all the used Haptic Factors to warn that the event is still active.
PULSE_WAVE	The Haptic sequence will play like the Wave but at 1.0 [100%] it will pulse all the used Factors to warn that the event is at 100%. [je Used as a SHIFT UP warning]
PULSE_LEVEL	The Haptic sequence will play like the Level but at 1.0 [100%] it will pulse all the used Factors to warn that the event is at 100%. [je Used as a TEMP warning]



8 MAGNETIC VEST CONNECTOR.

Developed to suit cockpit exit with automatic disconnection, as well as provide a convenient kill switch function. Tested at Philip Island. Type of connector used magnetic ring. Not found suitable, as rapid current surges caused the connector to bounce. Resulted in haptics losing power/comms. Not pursued further.



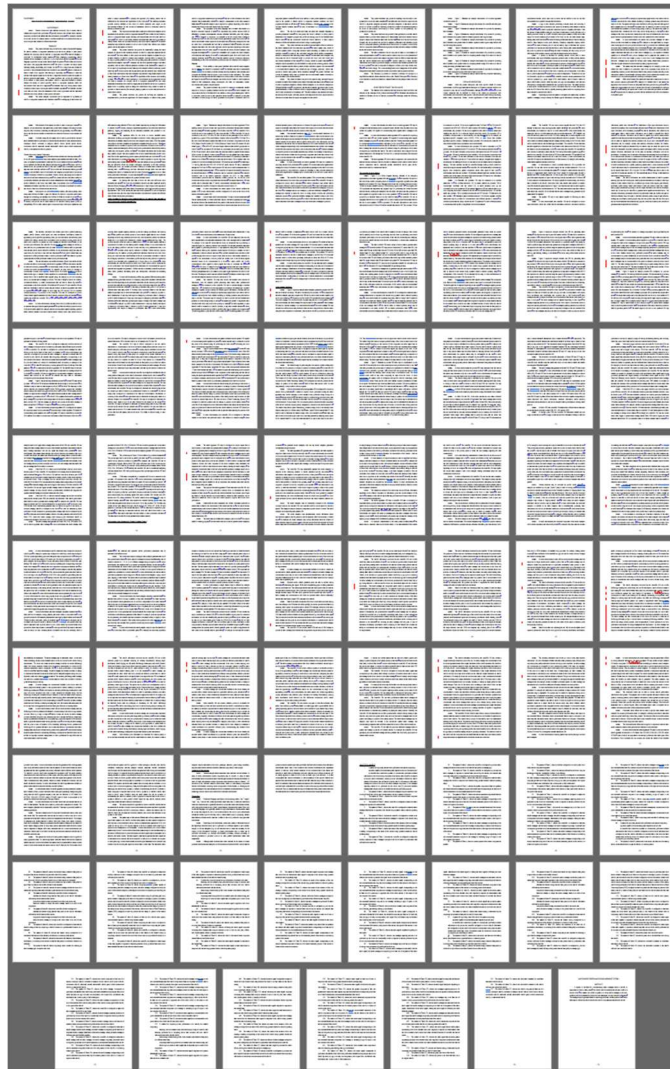
“Language of Metaphors”

- Patent engineering content generated 28th Dec 2019.
- Patent document received, reviewed DV/TL and feedback returned 29th Feb 2020.

Patent application

“AUDIO BASED PERFORMANCE ENHANCEMENT SYSTEM”

79 pages. Exciting reading material.



10 TESTING

10.1 PHILIP ISLAND TESTING

November 2018

Gen 1 Vest Controller. Vests 3, 4 with Gen 1 Haptics.



10.3 PORSCHE – RSR TRACK TESTING

February 2019, Abu Dhabi

10.4 PORSCHE - FORMULA E SIMUATOR TESTING

September 2019, Stuttgart Germany

Hardware-In-Loop testing

Formula E Simulator Testing

Driver reported the haptics on the back may limit driving to around a 1 hour period. The seat used was not an ideal fit for the driver. The driver lies a lot flatter in the cockpit than the RSR. A padded seat was used. There is possibly a lot more pressure on the back. Driver indicated the low front haptics were not well felt. The seat belt system did not provide pressure in this area.

Driver had discomfort with the rear outer haptics, middle unit. Possible future testing may involve amputation of these haptics.

10.5 PORT MELBOURNE - SIMULATOR TESTING



10.6 PORSCHE REMOTE SIMULATOR TESTING

Planning required for 2021

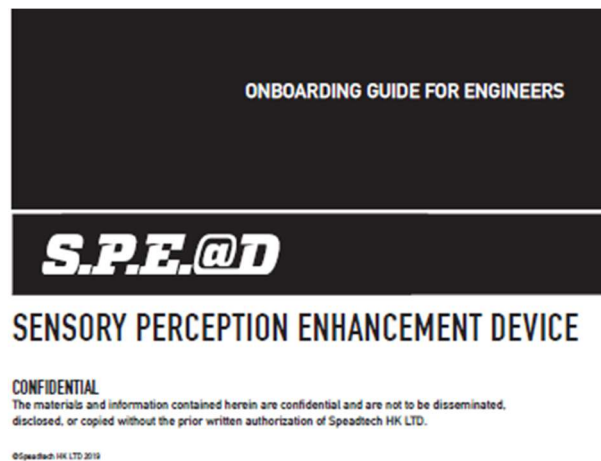
11 MEDIA PRODUCTIONS

11.1 GUIDES

11.1.1 ONBOARDING GUIDE FOR ENGINEERS

March 2019. 11 Pages.

S.P.E.@D Project_2019_Engineers_Guide_V2.pdf



11.1.2 ONBOARDING GUIDE FOR ENGINEERS – VIDEO

April 2019

<https://vimeo.com/321143695/39f96b56c8>

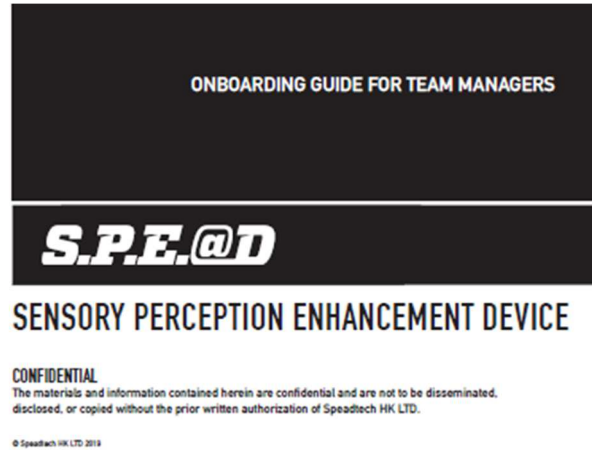


🔒 Spe@d Onboarding Guide for Engineers (Vimeo)

11.1.3 ONBOARDING GUIDE FOR TEAM MANAGERS

March 2019. 12 Pages.

S.P.E.@D Project_20219_Management_Guide_V2.pdf



11.2 TECHNICAL OVERVIEW

July 2019, 33 page technical overview.

This latest version was updated primarily for Porsche's reference.



<end of report>