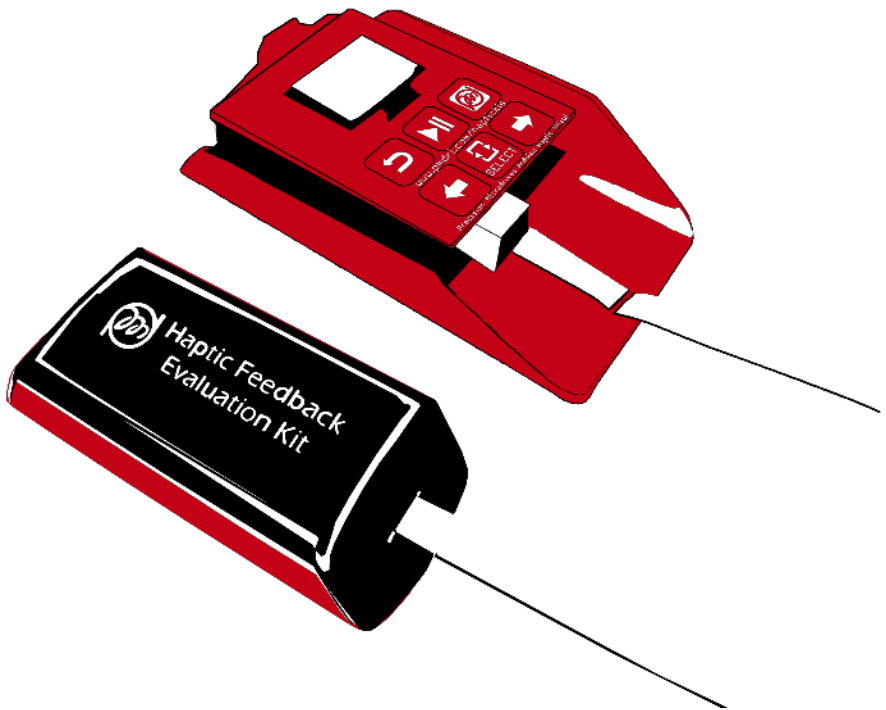


# Haptic Feedback Evaluation Kit

## Quick Start Guide



# 1 Introduction

Welcome to the Haptic Feedback Evaluation Kit! This Quick Start Guide will show you how to get up and running, whilst demonstrating the different modes of operation. There are also some useful references towards the end.

## Learn more

Please read the full User Manual for complete information on technical details and advice for accessing the advanced features of the Haptic Feedback Evaluation Kit.

## Additional Resources

You can find a range of additional resources available online at [precisionmicrodrives.com/haptic-kit](https://precisionmicrodrives.com/haptic-kit). Including:

- Downloadable PDF of this document
- Downloadable PDF of the full User Manual
- A4 printable posters for reference (Effect Table, True Haptics Menu Map, etc)
- Tutorials on the advanced features
- Arduino code for different Modes of Operation and example applications
- More resources as they are developed!

## Further Development


All of the actuators used in the kit are available off the shelf at [precisionmicrodrives.com](https://precisionmicrodrives.com) with no MOQ. You can see our full product range with their datasheets and easily place orders online. Alternatively we are happy to accept purchase orders by email.

## Contact Precision Microdrives

For questions about the Haptic Feedback Evaluation Kit, ordering and quotes, or technical queries please do not hesitate to get in touch:

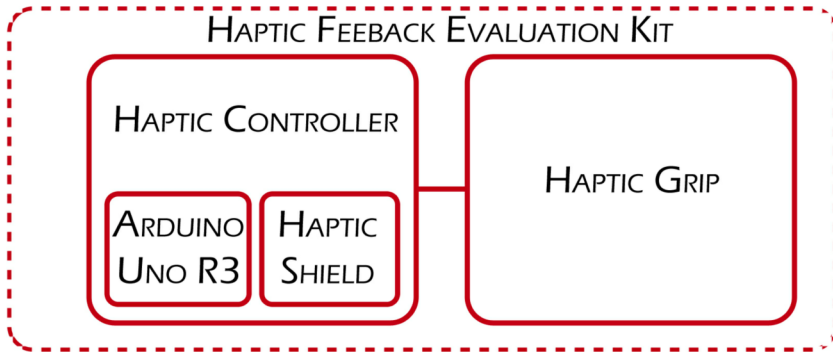
 [www.precisionmicrodrives.com](https://www.precisionmicrodrives.com)

 [enquiries@precisionmicrodrives.com](mailto:enquiries@precisionmicrodrives.com)

 +44 (0) 1932 252 482

## 2 System Overview

The Haptic Feedback Evaluation Kit is comprised of two main handheld units, the Haptic Controller and the Haptic Grip:



### Haptic Controller

The Haptic Controller consists of an Arduino Uno R3 and our Haptic Shield.

Arduino is an open source development platform for electronics, the Uno R3 is an Arduino board based on the Atmel ATmega328 microcontroller. The stackable headers allow for connection of other boards, called 'shields'.

The Precision Microdrives Haptic Shield is specially designed with capacitive touch buttons for input and uses a Texas Instruments DRV2605 haptic driver and MOSFET for output. The Haptic Controller acts as the 'brains' of the system.

### Haptic Grip

The Haptic Grip houses 4 different vibration actuators for users to experience haptic feedback and vibration alerting. This makes it easy to share results with others and feel the effects independently from the haptic feedback on the Haptic Controller. It is designed to have a form factor that can represent a variety of end applications, such as hand held instruments or joystick interfaces.

## 3 Setup & Installation

The Haptic Feedback Evaluation Kit arrives completely assembled with all hardware provided in the box.

### Power

All that is required to start is providing adequate power to the Haptic Controller via the USB port. The Arduino includes a DC power socket which is designed to offer a choice in power supply.

**ATTENTION: DO NOT use the DC power connector!**

It is not possible to use the DC socket with the Haptic Shield. Powering via the DC socket risks immediately damaging the onboard analogue switch.

If using a USB port on a computer or laptop you will need to install the Arduino drivers. The kit draws current from the USB port, when the actuators are vibrating this can peak over 100mA. By installing the driver the Arduino is able to negotiate up to 500 mA. Not installing the drivers risks limiting the current to the motors, thereby reducing the performance and in some cases not allowing the kit to start-up.

In some computers, several USB ports can use the same internal power supply. If possible remove other USB devices that may be connected to the same line as the kit.

### Drivers and Software

Installing the drivers and software for the Aduino Uno R3 is simple, but updated periodically. Therefore it is best to get the latest version and instructions from the Arduino website (URL is case-sensitive):

<http://arduino.cc/en/Guide/HomePage>

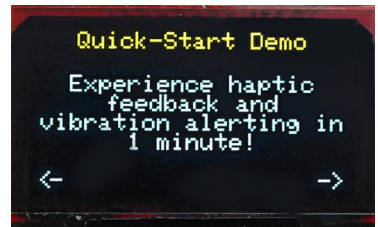
- Install the Arduino Uno R3 drivers
- Install the Arduino Environment (software required to load different firmware to change modes of operation)

## 4 Intro Mode

The Intro Mode firmware is loaded onto the Haptic Controller prior to shipping. After successfully completing the installation process and providing power, the kit will automatically start and the Precision Microdrives logo will appear on the OLED main screen.

There are four tutorials in the Intro Mode, use the **left** and **right** buttons to move between them and press the **select** button to start:

- Quick-Start Demo
- Haptic Feedback Tutorial
- Vibration Alerting Tutorial
- DRV2605 Overview



### Develop Understanding

Each tutorial has several slides for you to read about the concepts demonstrated. They are easy to follow and you can go back by pressing the **left** button, or exit with the **back** button.

### Feel Effects

At specific points in each tutorial you will be prompted to press the **play** button. Different effects are played on the Haptic Grip or the Haptic Controller, you can repeat them by pressing the **play** button a second time.

### Apply

Not only will the tutorials walk you through the concepts of vibration alerting and haptic feedback, some also include example applications. Start thinking about how you would use haptics to improve your product, then try out the Engineering Mode.

## 5 Engineering Mode

The Engineering Mode is a different firmware that needs to be loaded into the Arduino, to perform this you will need to have installed the Arduino Environment and have downloaded the code from [precisionmicrodrives.com/haptic-kit/codes](https://precisionmicrodrives.com/haptic-kit/codes).

It is also recommended you read the User Manual (section 5) to get the most out of the Engineering Mode.

### Upload the Code

To enter engineering mode, you need to compile and upload the code through the Arduino Environment. Once you have downloaded and extracted the code to your chosen folder, open the EngineeringMode.ino file. You can then click the 'upload' button in the Arduino IDE.

### Using True Haptics

Within Engineering Mode you can experience haptic feedback, provided by the DRV2605. There are 6 libraries that each play 123 haptic effects differently. Navigate through clicks, bumps, pulses, and many more options.

Press the play button to play the chosen effect and press the PMD button to change the output actuator. The True Haptics Menu Map and Effect ID Table (at the end of this guide) are designed to help you find effects quickly.

### Using Vibration Alerting

Vibration alerts can be played through the onboard MOSFET and PWM. Build your own vibration alerting waveform by setting each variable in the Vibration Alerting section, including vibration power, vibration waveform, on time, and off time.

### Keep Developing

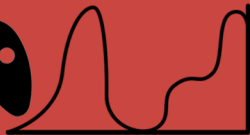
Try using the DRV2605 library and example code to start prototyping your own system. The Arduino can be used to accept inputs, the library lets you easily interface with the DRV2605, and you can connect to an external actuator using the terminals on the Haptic Shield.

# 6 Haptic Feedback vs Vibration Alerting

## Haptic Feedback

VS

## Vibration Alerting



Vibration Profile



Advanced vibration patterns to convey information, simulate clicks & button presses with predefined haptic waveforms.

Simple vibration patterns to notify users of an event. Strong vibrations to catch operator's attention.



Conveys Information



Discrete



Enhanced Experience



Simple & Inexpensive



Discrete



Effective Alert

- Telecommunications
- Auto Dashboards
- Capacitive Touch
- Touchscreens
- Control Sticks
- Videogames



- Scanners and Detectors
- Safety Equipment
- Electronic Tools
- Pagers
- Meters
- GPS



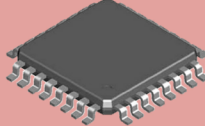
LRA / ERM

\$1.50



Haptics Driver

\$0.70 ~ \$1.20



Host Microcontroller

Budgetary pricing for 10k pcs



Motor IC / MOSFET

\$0.20 ~ \$0.70



ERM / LRA

\$1.25

\$2.20 ~ \$2.70

# Low Cost

\$1.45 ~ \$1.95

# 7 DRV2605 Library

Parent	Notes	Function Syntax	Description	Parameters	Returns
Motor.cpp	Recommended object: <b>Motor</b> <code>motor = Motor[]</code> ; The Motor object encapsulates DRV2605 functionality and gives a simpler interface to playing vibration alerts and haptic effects. Only one should be instantiated at a time, as demonstrated in the IntroMode and EngineeringMode sketches	<code>selectMotor( motorID );</code>	Selects the output motor on the grip. Required even if using external actuator is being used - <code>autoCalibrate()</code>	<b>motorID</b> : uint8_t	Void
		<code>isCalibrated();</code>	Checks to see if selected actuator has undergone calibration	None	Boolean Value True = calibrated False = not calibrated
		<code>autoCalibrate();</code>	Runs auto calibration on selected motor. <code>selectMotor()</code> must be called first	None	Void
		<code>playVibAlert( waveform , pwr , onTime , offTime );</code>	Plays vibration alert on selected actuator, LRA is not supported so <code>motorID = 3</code> . Implements a continuous loop, use interrupts or edit function to stop.	<b>waveform</b> : uint8_t <b>pwr</b> : uint8_t <b>onTime</b> : uint8_t <b>offTime</b> : uint8_t	Void
		<code>playFullHaptic( library , effect );</code>	Plays haptic effect from DRV2605 on selected actuator. If LRA is selected ( <code>motorID = 3</code> ) then library 6 will be used	<b>library</b> : uint8_t <b>effect</b> : uint8_t	Void
		<code>getMotorID();</code>	Gets current <code>motorID</code>	None	Int
		<code>isPlaying();</code>	Checks to see if an actuator is playing a haptic effect	None	Boolean Value True = playing False = not playing
		<code>isPlayingVib();</code>	Checks to see if an actuator is playing a vibration alert. Note 'off times' return a true value. Must be called in interrupt	None	Boolean Value True = playing False = not playing
		<code>stopVibAlert();</code>	Stops the vibration alerting being played. Must be called in interrupt	None	Void
		<code>getMotorName();</code>	Returns current motor ID product code	None	Char string
DRV2605.cpp	Recommended object: <b>extern DRV2605 drv2605</b> ; The DRV2605 class abstracts away the I2C communications to the DRV2605 chip, providing a streamlined interface for playing effects. Only one DRV2605 object should be instantiated. If using the DRV2605 object from the Motor class use 'extern', as above.	<code>autoCal( ratedVoltage , overdriveClamp , LRA , compensation , backEMF , feedback );</code>	Run the DRV2605's auto-calibration routine on the selected actuator with the values passed in. If auto-calibration is successful (function returns true) the compensation, back EMF and feedback values have been set	<b>ratedVoltage</b> : uint8_t <b>overdriveClamp</b> : uint8_t <b>LRA</b> : boolean <b>compensation</b> : uint8_t* <b>backEMF</b> : uint8_t* <b>feedback</b> : uint8_t*	Boolean value True = successful False = unsuccessful
		<code>playFullHaptic( library , effect , ratedVoltage , overdriveClamp , compensation , backEMF , feedback );</code>	Plays haptic effect from DRV2605 on selected actuator. Pass in compensation, back EMF, and feedback values returned from auto-calibration, or manually adjusted values	<b>library</b> : uint8_t <b>effect</b> : uint8_t <b>ratedVoltage</b> : uint8_t <b>overdriveClamp</b> : uint8_t <b>compensation</b> : uint8_t <b>backEMF</b> : uint8_t <b>feedback</b> : uint8_t	Void
debug.cpp	N/A	<code>freeRAM();</code>	Returns amount of unused RAM space in DRV2605	None	Int

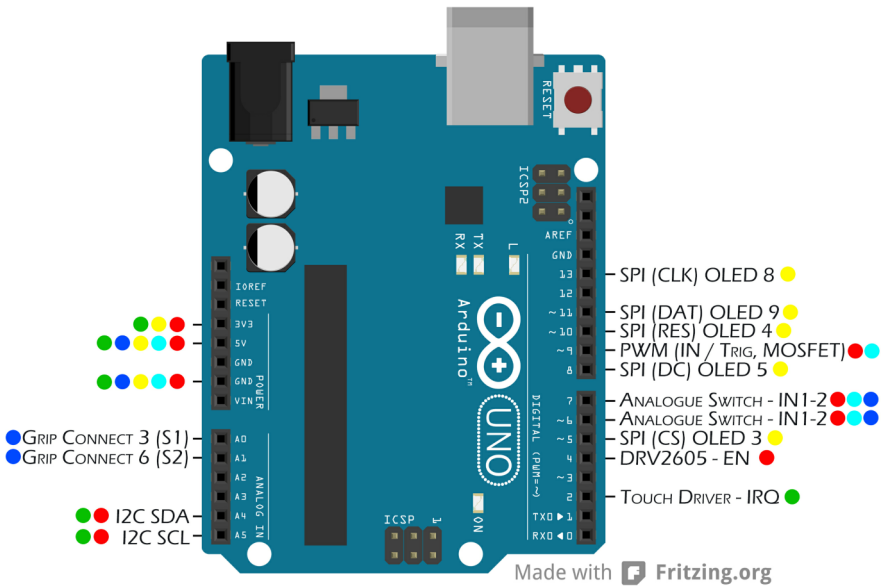
Parameter	Type & Limits	Values	Description
<b>motorID</b>	0 ≤ int ≤ 3	0 = 305-000 1 = 306-109 2 = 308-102 3 = C10-100	Selects the output actuator. Select 3 if using external LRA
<b>waveform</b>	0 ≤ int ≤ 3	0 = Square 1 = Sine 2 = Triangle 3 = Sawtooth	Changes the output waveform for vibration alerts
<b>pwr</b>	0 ≤ int ≤ 100	0% - 100%	The peak output strength of the selected waveform, always goes from 0% to pwr value
<b>onTime</b>	0 ≤ int ≤ 255	Tenths of Seconds	The amount of time the vibration alert vibrates over
<b>offTime</b>	0 ≤ int ≤ 255	Tenths of Seconds	The amount of time between vibration alerts
<b>library</b>	1 ≤ int ≤ 6	1 - 5 = ERM 6 = LRA	The haptic library on the DRV2605 to be used
<b>effect</b>	1 ≤ int ≤ 123	See Effect ID table	The haptic effect on the DRV2605 to be used
<b>ratedVoltage</b>	0 ≤ int ≤ 255	Voltage applied to ERM = $\text{ratedVoltage} \times [5.44 \text{ V} / 255]$	See full DRV2605 datasheet for detailed explanation and calculation of LRA voltage
<b>overdriveClamp</b>	0 ≤ int ≤ 255	Voltage applied to ERM = $\text{overdriveClamp} \times [5.6 \text{ V} / 255]$	Peak voltage allowed in all modes of DRV2605 operation
<b>LRA</b>	bool	True = LRA Mode, False = ERM Mode	Sets bit 7 of register 0x1A, putting the DRV2605 into LRA or ERM mode
<b>compensation</b>	0 ≤ int ≤ 255	Auto Calibration Compensation Coefficient = $1 + \text{compensation} / 255$	Manually adjusts compensation for resistive losses in the driver
<b>backEMF</b>	0 ≤ int ≤ 255	Auto Calibration Back EMF [V] = $(\text{backEMF} / 255) \times (4.88 \text{ V} / \text{BEMFGain})$	Manually adjusts results for back EMF of the actuator, <b>BEMFGain</b> set by <b>feedback</b>
<b>feedback</b>	int, only specific values valid	N/A	Manually adjusts feedback control register, see full DRV2605 datasheet for details

## 8 Pin Mapping

# Pin Mapping

### PIN REQUIREMENTS

<b>OLED</b>	3V3, 5V, GND, 5, 8, 10, 11, 13	<b>CAPACITIVE TOUCH</b>	3V3, 5V, GND, A4, A5, 2
<b>HAPTIC GRIP</b>	5V, GND, A0, A1, 6, 7	<b>MOSFET</b>	5V, GND, 6, 7, 9
<b>DRV2605</b>	3V3, 5V, GND, A4, A5, 4, 6, 7, 9		



### I2C Addresses

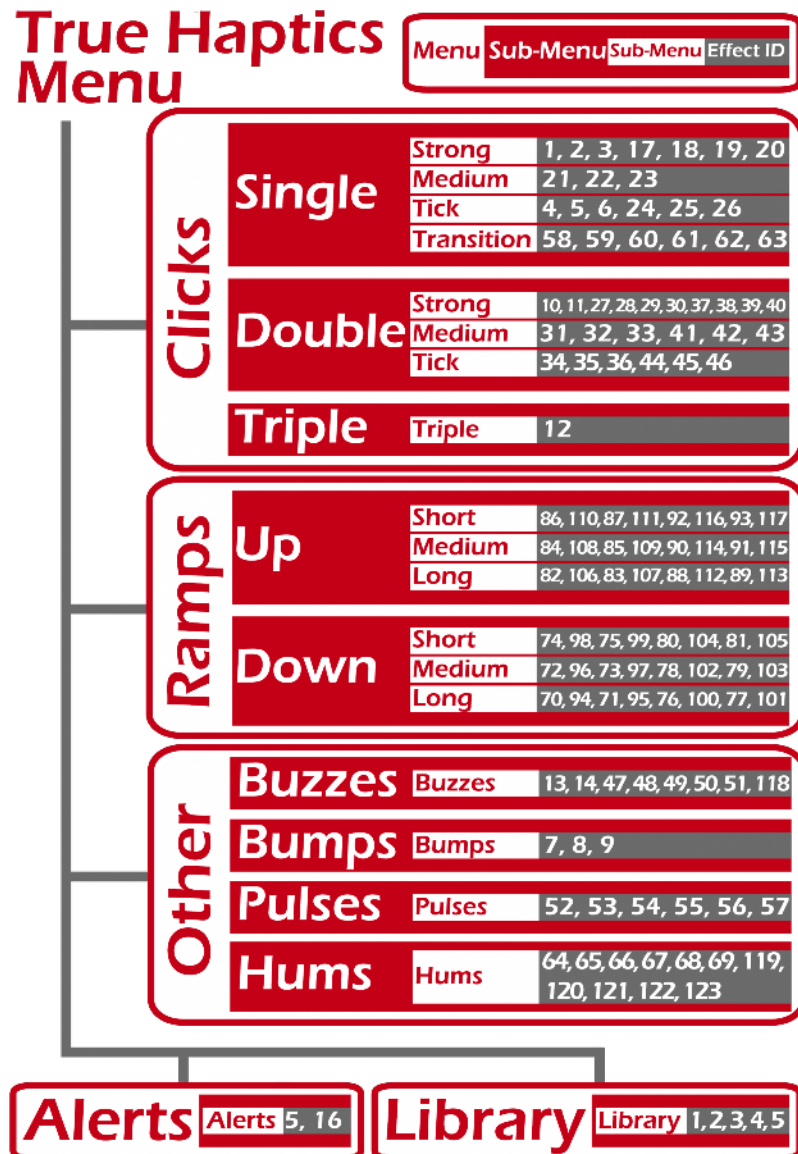
Using 7-bit Addressing

**Capacitive Touch Driver MPR121** 0x5D

**Haptic Driver DRV2605** 0x5A

## 9 True Haptics Menu Map

### True Haptics Menu



# 10 Effect Table

Effect ID	Waveform	Menu	Effect ID	Waveform	Menu
1	Strong Click 100%	Clicks > Single > Strong	63	Transition Click 6 10%	Clicks > Single > Transition
2	Strong Click 60%	Clicks > Single > Strong	64	Transition Hum 1 100%	Other > Hums
3	Strong Click 30%	Clicks > Single > Strong	65	Transition Hum 2 80%	Other > Hums
4	Sharp Click 100%	Clicks > Single > Tick	66	Transition Hum 3 60%	Other > Hums
5	Sharp Click 60%	Clicks > Single > Tick	67	Transition Hum 4 40%	Other > Hums
6	Sharp Click 30%	Clicks > Single > Tick	68	Transition Hum 5 20%	Other > Hums
7	Soft Bump 100%	Other > Bumps	69	Transition Hum 6 10%	Other > Hums
8	Soft Bump 60%	Other > Bumps	70	Transition Ramp Down Long Smooth 1 100-0%	Ramps > Down > Long
9	Soft Bump 30%	Other > Bumps	71	Transition Ramp Down Long Smooth 2 100-0%	Ramps > Down > Long
10	Double Click 100%	Clicks > Double > Strong	72	Transition Ramp Down Medium Smooth 1 100-0%	Ramps > Down > Medium
11	Double Click 60%	Clicks > Double > Strong	73	Transition Ramp Down Medium Smooth 2 100-0%	Ramps > Down > Medium
12	Triple Click 100%	Clicks > Triple	74	Transition Ramp Down Short Smooth 1 100-0%	Ramps > Down > Strong
13	Soft Fuzz 60%	Other > Buzzes	75	Transition Ramp Down Short Smooth 2 100-0%	Ramps > Down > Strong
14	Strong Buzz 100%	Other > Buzzes	76	Transition Ramp Down Long Sharp 1 100-0%	Ramps > Down > Long
15	750ms Alert	Other > Alerts	77	Transition Ramp Down Long Sharp 2 100-0%	Ramps > Down > Long
16	1000ms Alert	Other > Alerts	78	Transition Ramp Down Medium Sharp 1 100-0%	Ramps > Down > Medium
17	Strong Click 1 100%	Clicks > Single > Strong	79	Transition Ramp Down Medium Sharp 2 100-0%	Ramps > Down > Medium
18	Strong Click 2 80%	Clicks > Single > Strong	80	Transition Ramp Down Short Sharp 1 100-0%	Ramps > Down > Strong
19	Strong Click 3 60%	Clicks > Single > Strong	81	Transition Ramp Down Short Sharp 2 100-0%	Ramps > Down > Strong
20	Strong Click 4 30%	Clicks > Single > Strong	82	Transition Ramp Up Long Smooth 1 0-100%	Ramps > Up > Long
21	Medium Click 1 100%	Clicks > Single > Medium	83	Transition Ramp Up Long Smooth 2 0-100%	Ramps > Up > Long
22	Medium Click 2 80%	Clicks > Single > Medium	84	Transition Ramp Up Medium Smooth 1 0-100%	Ramps > Up > Medium
23	Medium Click 3 60%	Clicks > Single > Medium	85	Transition Ramp Up Medium Smooth 2 0-100%	Ramps > Up > Medium
24	Sharp Tick 1 100%	Clicks > Single > Tick	86	Transition Ramp Up Short Smooth 1 0-100%	Ramps > Up > Short
25	Sharp Tick 2 80%	Clicks > Single > Tick	87	Transition Ramp Up Short Smooth 2 0-100%	Ramps > Up > Short
26	Sharp Tick 3 60%	Clicks > Single > Tick	88	Transition Ramp Up Long Sharp 1 0-100%	Ramps > Up > Long
27	Short Double Click Strong 1 100%	Clicks > Double > Strong	89	Transition Ramp Up Long Sharp 2 0-100%	Ramps > Up > Long
28	Short Double Click Strong 2 80%	Clicks > Double > Strong	90	Transition Ramp Up Medium Sharp 1 0-100%	Ramps > Up > Medium
29	Short Double Click Strong 3 60%	Clicks > Double > Strong	91	Transition Ramp Up Medium Sharp 2 0-100%	Ramps > Up > Medium
30	Short Double Click Strong 4 30%	Clicks > Double > Strong	92	Transition Ramp Up Short Sharp 1 0-100%	Ramps > Up > Short
31	Short Double Click Medium 1 100%	Clicks > Double > Medium	93	Transition Ramp Up Short Sharp 2 0-100%	Ramps > Up > Short
32	Short Double Click Medium 2 80%	Clicks > Double > Medium	94	Transition Ramp Down Long Smooth 1 50-0%	Ramps > Down > Long
33	Short Double Click Medium 3 60%	Clicks > Double > Medium	95	Transition Ramp Down Long Smooth 2 50-0%	Ramps > Down > Long
34	Short Double Sharp Tick 1 100%	Clicks > Double > Tick	96	Transition Ramp Down Medium Smooth 1 50-0%	Ramps > Down > Medium
35	Short Double Sharp Tick 2 80%	Clicks > Double > Tick	97	Transition Ramp Down Medium Smooth 2 50-0%	Ramps > Down > Medium
36	Short Double Sharp Tick 3 60%	Clicks > Double > Tick	98	Transition Ramp Down Short Smooth 1 50-0%	Ramps > Down > Strong
37	Long Double Sharp Click Strong 1 100%	Clicks > Double > Strong	99	Transition Ramp Down Short Smooth 2 50-0%	Ramps > Down > Strong
38	Long Double Sharp Click Strong 2 80%	Clicks > Double > Strong	100	Transition Ramp Down Long Sharp 1 50-0%	Ramps > Down > Long
39	Long Double Sharp Click Strong 3 60%	Clicks > Double > Strong	101	Transition Ramp Down Long Sharp 2 50-0%	Ramps > Down > Long
40	Long Double Sharp Click Strong 4 30%	Clicks > Double > Strong	102	Transition Ramp Down Medium Sharp 1 50-0%	Ramps > Down > Medium
41	Long Double Sharp Click Medium 1 100%	Clicks > Double > Medium	103	Transition Ramp Down Medium Sharp 2 50-0%	Ramps > Down > Medium
42	Long Double Sharp Click Medium 2 80%	Clicks > Double > Medium	104	Transition Ramp Down Short Sharp 1 50-0%	Ramps > Down > Strong
43	Long Double Sharp Click Medium 3 60%	Clicks > Double > Medium	105	Transition Ramp Down Short Sharp 2 50-0%	Ramps > Down > Strong
44	Long Double Sharp Tick 1 100%	Clicks > Double > Tick	106	Transition Ramp Up Long Smooth 1 0-50%	Ramps > Up > Long
45	Long Double Sharp Tick 2 80%	Clicks > Double > Tick	107	Transition Ramp Up Long Smooth 2 0-50%	Ramps > Up > Long
46	Long Double Sharp Tick 3 60%	Clicks > Double > Tick	108	Transition Ramp Up Medium Smooth 1 0-50%	Ramps > Up > Medium
47	Buzz 1 100%	Other > Buzzes	109	Transition Ramp Up Medium Smooth 2 0-50%	Ramps > Up > Medium
48	Buzz 2 80%	Other > Buzzes	110	Transition Ramp Up Short Smooth 1 0-50%	Ramps > Up > Short
49	Buzz 3 60%	Other > Buzzes	111	Transition Ramp Up Short Smooth 2 0-50%	Ramps > Up > Short
50	Buzz 4 40%	Other > Buzzes	112	Transition Ramp Up Long Sharp 1 0-50%	Ramps > Up > Long
51	Buzz 5 20%	Other > Buzzes	113	Transition Ramp Up Long Sharp 2 0-50%	Ramps > Up > Long
52	Pulsing Strong 1 100%	Other > Pulses	114	Transition Ramp Up Medium Sharp 1 0-50%	Ramps > Up > Medium

# Effect Table *continued*

Effect ID	Waveform	Menu	Effect ID	Waveform	Menu
53	Pulsing Strong 2 80%	Other > Pulses	115	Transition Ramp Up Medium Sharp 2 0-50%	Ramps > Up > Medium
54	Pulsing Medium 1 100%	Other > Pulses	116	Transition Ramp Up Short Sharp 1 0-50%	Ramps > Up > Short
55	Pulsing Medium 2 60%	Other > Pulses	117	Transition Ramp Up Short Sharp 2 0-50%	Ramps > Up > Short
56	Pulsing Sharp 1 100%	Other > Pulses	118	Long Buzz for Programmatic Topping 100%	Other > Buzzes
57	Pulsing Sharp 2 60%	Other > Pulses	119	Smooth Hum 50%	Other > Hums
58	Transition Click 1 100%	Clicks > Single > Transition	120	Smooth Hum 40%	Other > Hums
59	Transition Click 2 80%	Clicks > Single > Transition	121	Smooth Hum 30%	Other > Hums
60	Transition Click 3 60%	Clicks > Single > Transition	122	Smooth Hum 20%	Other > Hums
61	Transition Click 4 40%	Clicks > Single > Transition	123	Smooth Hum 10%	Other > Hums
62	Transition Click 5 20%	Clicks > Single > Transition			

## See also

Arduino UNO R3 Drivers and Software : <http://arduino.cc/en/Guide/HomePage>

DRV2605 Datasheet : <http://www.ti.com/product/drv2605>

Tutorials & Example Applications : [www.precisionmicrodrives.com/haptic-kit/tutorials-and-examples](http://www.precisionmicrodrives.com/haptic-kit/tutorials-and-examples)

## Customer Support

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Phone : +44 (0) 1932 252482.

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