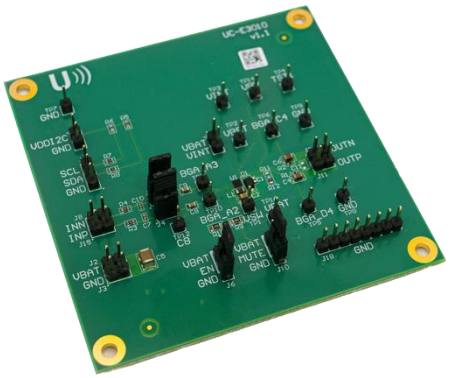
EVALUATION BOARD FOR ASIC LINEAR AMPLIFIER

TARVOS EVALUATION BOARD 1.1 UC-E3010 DATASHEET



Tarvos evaluation board 1.1 UC-E3010 provides the access to the key features of the ASIC linear audio amplifier Tarvos 1.0 UC P3010. It allows acoustical performance measurements of Usound MEMS speakers in combination with the Carme kits.

Tarvos 1.0 UC-P3010 is included in the Tarvos evaluation board 1.1 with default configuration to provide optimized performance of the USound MEMS speakers.

FEATURES

- Pre-configurated for Conamara or Ganymede MEMS speaker series
- Available gain 18, 24, 30 dB
- Compatible with Carme kits for acoustical measurements
- Power consumption measurements

CONTENTS

REVISION HISTORY:
March 2023: First release
July 2023: Updated pages 5, 6; Updated Schematic, BOM; Ordering information added
June 2024: Product code table updated, Evaluation board schematic updated page 5; Appendix 2 updated page 10

OVERVIEW

Tarvos evaluation board 1.1, UC-E3010, allows testing of performance and key features of Tarvos 1.0 ASIC linear audio amplifier UC-P3010. Tarvos 1.0 UC-P3010 is a high-voltage linear audio amplifier with integrated DC-DC boost converter. The device can provide up to 28 V_{PP} and draws below 1.0 mA of quiescent current, or 0.5 µA when Tarvos 1.0 UC-P3010 is disabled, from a 3.6 V supply.
It's featuring a differential input, gain, DC/DC boost converter (V_{BST}), and DC bias (V_{BP}) to fully optimize the performance of USound MEMS speakers depending on the application. Therefore, Tarvos 1.0 UC-P3010 is provided on the Tarvos evaluation board 1.1 UC-E3010 with the corresponding configurations.

H-configuration Tarvos 1.0 UC-P3010 for Conamara series:
Gain 18 dB, 24 dB, 30 dB
DC-DC Boost V_{BST}=14 V, MEMS speaker $V_{DC\ BIAS}$=10 V
G-configuration Tarvos 1.0 UC-P3010 for Ganymede series:
Gain 18 dB, 24 dB, 30 dB
DC-DC Boost V_{BST}=14 V, MEMS speaker $V_{DC\ BIAS}$=14 V

Ordering product codes	
UC-E3010-H18	Tarvos Evaluation Board 1.1 with H-configuration for Conamara series, gain 18 dB (UA-C0503-3T, UA-C0603-3F, UA-C0603-3T)
UC-E3010-H24	Tarvos Evaluation Board 1.1 with H-configuration for Conamara series, gain 24 dB (UA-C0503-3T, UA-C0603-3F, UA-C0603-3T)
UC-E3010-H30	Tarvos Evaluation Board 1.1 with H-configuration for Conamara series, gain 30 dB (UA-C0503-3T, UA-C0603-3F, UA-C0603-3T)
UC-E3010-G18	Tarvos Evaluation Board 1.1 with G-configuration for Ganymede series, gain 18 dB (UT-P2023, UT-P2020, UT-P2016)
UC-E3010-G24	Tarvos Evaluation Board 1.1 with G-configuration for Ganymede series, gain 24 dB (UT-P2023, UT-P2020, UT-P2016)
UC-E3010-G30	Tarvos Evaluation Board 1.1 with G-configuration for Ganymede series, gain 30 dB (UT-P2023, UT-P2020, UT-P2016)

Table 1. Ordering product codes

Tarvos evaluation board 1.1 UC-E3010 is shown in Figure 1. It can be supplied with an external power supply (2.7 V ≤ V_{BAT} ≤ 5.5 V) and an audio signal source.

Additionally, the evaluation board enables the user to perform acoustical measurements of USound MEMS speakers in combination with Usound measurement adapters Carme kit: UJ-E1040C06 for Conamara 6 mm, UJ-E1040C05 for Conamara 5 mm or UJ-E1040G00 for Ganymede series.

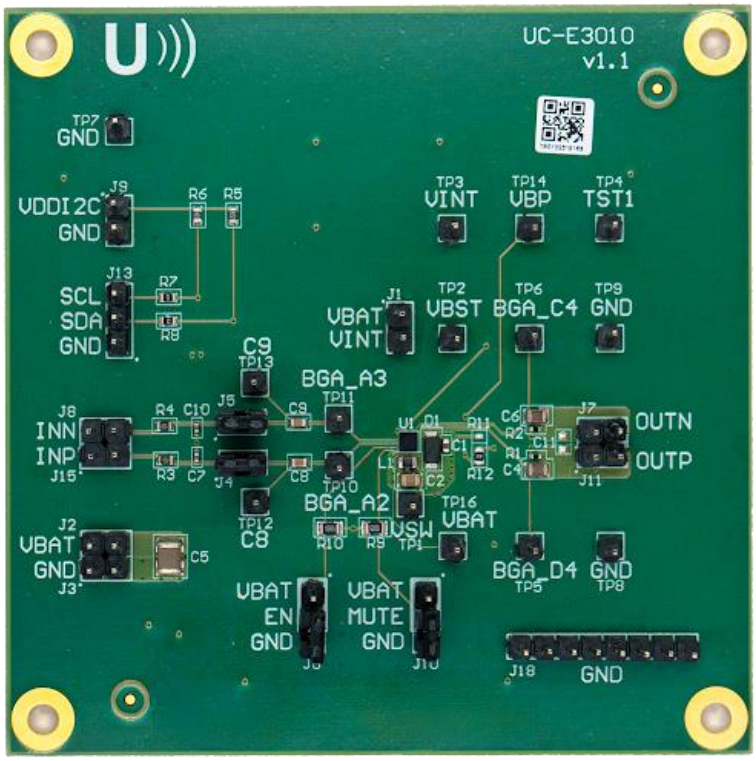


Figure 1. **Tarvos evaluation board 1.1 UC-E3010 top view**

QUICK START GUIDE

1. Drive enable (EN) of J6 to GND for starting with a disabled Tarvos evaluation board 1.1 UC-P3010.
2. Connect the load (i.e. Conamara or Ganymede MEMS speakers) across OUTP (J11) and OUTN (J7). The Carme kits (UJ-E1040G00, UJ-E1040C05, UJ-E1040C06) can be directly connected to these headers.
3. Connect a power supply (2.7 V ≤ VBAT ≤ 5.5 V) and ground reference, respectively to VBAT (J2) and GND (J3) headers on the evaluation board.
4. Connect a differential audio input to either INN and INP (including a low pass filter) or to J5-2 and J4-2 (without including the low pass filter). The latter is recommended when using Audio Instrumentations (i.e. Audio Precision, SoundCheck, etc.).
5. Drive VDDI2C of J9 to GND.
6. Drive MUTE of J10 to GND.
7. Power on the board.
8. Drive enable (EN) of J6 to VBAT for normal operation.
9. Provide the audio input signal and measure the output on OUTN (J7) and OUTP (J11).

DON'TS

- Do not send any I2C commands without support from USound

OPERATING CONDITIONS

Table 2 shows the operating temperature and supply voltage ranges for Tarvos evaluation board 1.1 UC-E3010.

Operating Conditions	
Temperature range: ($T_{MIN} \leq T_A \leq T_{MAX}$)	-20^0 C $\leq T_A \leq 85^0$ C
Supply Voltage (V_{BAT})	2.7 V $\leq V_{BAT} \leq$ 5.5 V

Table 2. Tarvos evaluation board 1.1 UC-E3010 operating conditions

EVALUATION BOARD SCHEMATIC

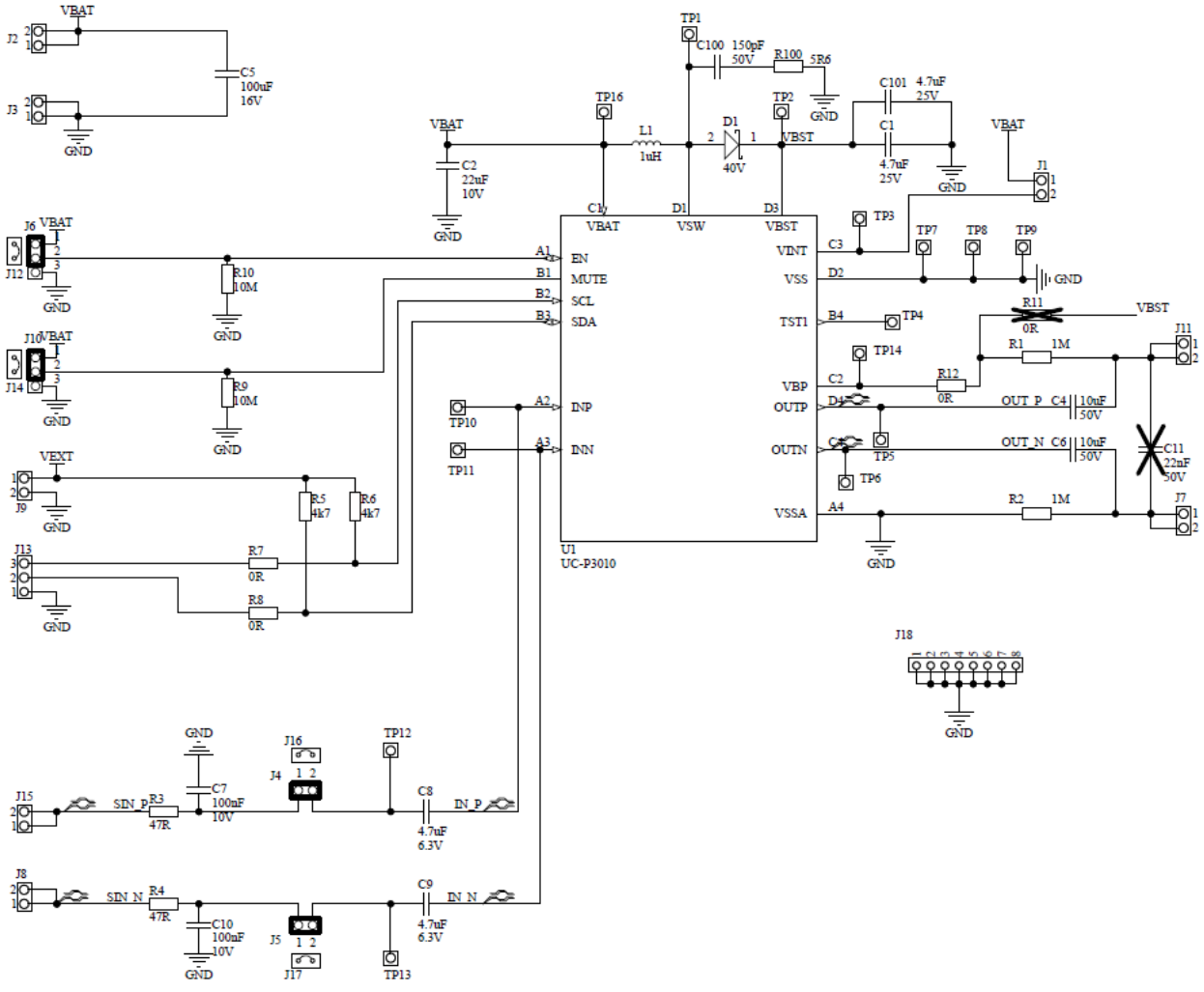


Figure 2. Tarvos evaluation board 1.1 UC-E3010 schematic

CONNECTIONS

Table 3 displays all the connections available on the Tarvos evaluation board 1.1 UC-E3010.

Designator	Function	Notes
J2	VBAT	Power supply, positive terminal
J3	GND	Power supply, negative terminal
J4	INP – HEADER	J4 allows separation of INP (J15) and a low pass filter stage (cut-off frequency at 30kHz) from the coupling capacitor C. If the low pass filter is desired, short J4-1 and J4-2, and apply the positive audio signal to J15 (INP). If the low pass filter is not desired ensure there is not any contact between J4-1 and J4-2 and connect the positive audio signal to J4-2 (TP12).
J5	INN – HEADER	J5 allows separation of INP (J8) and a low pass filter stage (cut-off frequency at 30kHz) from the coupling capacitor C9. If the low pass filter is desired, short J5-1 and J5-2, and apply the positive audio signal to J8 (INP). If the low pass filter is not desired ensure there is not any contact between J5-1 and J5-2 and connect the positive audio signal to J5-2 (TP13).
J6	ENABLE	Active High Enable. Drive EN low to disable the device. Connect EN to VBAT for normal operation.
J7	OUTN	Negative audio output terminal (to be connected to MEMS speaker negative electrode)
J8	INN	Negative audio input terminal with a following low pass filter stage (cut-off frequency at 30 kHz)
J9	VEXT	External digital supply for pulling up the I^2C lines with R5 (not assembled) and R6 (not assembled) to the digital supply domain
J10	MUTE	MUTE allows for great reduction of pop and click sound when enabling the chip
J11	OUTP	Positive audio output terminal (to be connected to MEMS speaker positive electrode)
J13	I^2C SDA/SCL/GND	I^2C terminals SDA, SCL and GND for connection to an I^2C Master
J15	INP	Positive audio input terminal with a following low pass filter stage (cut-off frequency at 30 kHz)
J18	GND	Ground connections for instrumentation references

Table 3. **Tarvos evaluation board 1.1 UC-E3010 connections**

APPENDIX 1 - POWER CONSUMPTION MEASUREMENTS PROCEDURE

USound MEMS speakers have a frequency dependent impedance (showing a capacitance behaviour), so the power consumption is strongly dependent on the frequency of the signal. Therefore, only power consumption measurements such as the quiescent current from a certain power supply can be taken from a static DC current measurement instrument (i.e. Multimeter).
In order to provide a more accurate power consumption measurement within the context of the application (i.e. audio playback), various measurement signals (i.e. IEC Noise 60268-1) are used and the average of the power consumption over time must be taken.

HARDWARE MEASUREMENT SETUP

Power consumption measurements with audio playback can be carried out with the appropriate instrumentation (with enough sampling frequency, low enough noise floor, enough sensitivity and range, etc.). Instrumentation used for measuring audio signals (for example: Audio Precision instrumentation) usually provide the means necessary to also perform such power consumption measurements. Therefore, an Audio Precision instrument is used in this section to set a reference example on how to measure power consumption with a frequency and amplitude changing signal, such as audio songs or IEC Noise.

For performing a power consumption measurement at a certain dBSPL with Tarvos evaluation board 1.1 UC-E3010 and any kind of signal, the following devices are needed:

- Power Supply (i.e. HMC 8043)
- APX measurement system (i.e. 525 or 515)
- 1Ω shunt

Figure 3 displays how the different elements must be connected.

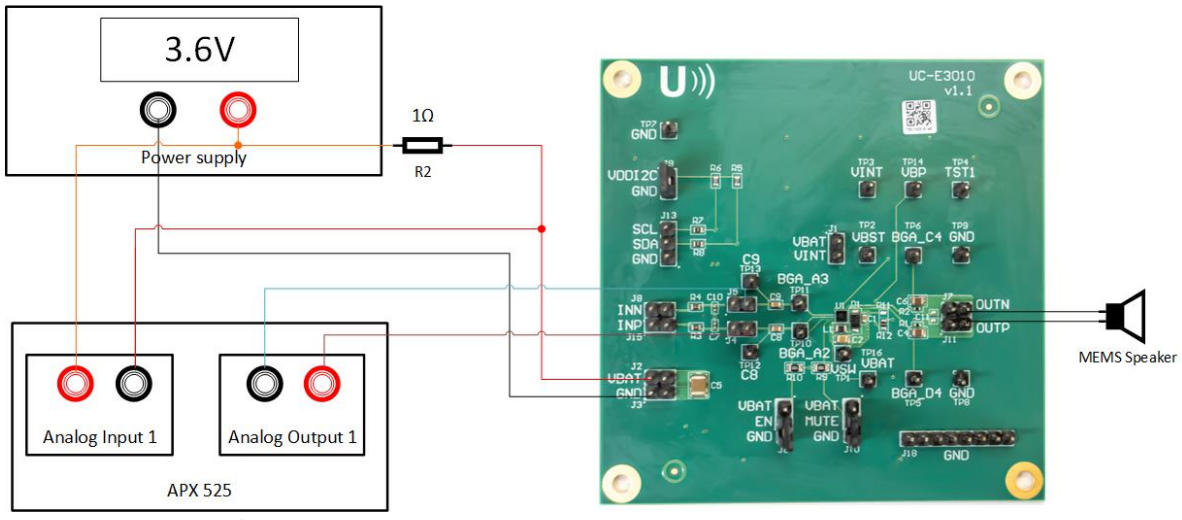


Figure 3. Power consumption measurement setup with UC-E3010

SOFTWARE MEASUREMENT SETUP

First, the necessary settings for input and output need to be chosen in the APx measurement software. These settings can be found in the signal path setup and should be set according to Figure 4. It is important that the option for the high-pass filter is selected to be “DC”.

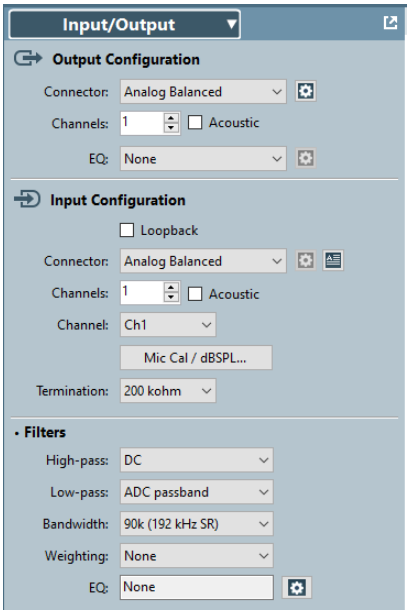


Figure 4. **Input / Output settings in the APx software**

The signal acquisition measurement type is preferred for its higher sampling rate (i.e. 90 kHz or even higher) that can be set (in the Signal Path Setup, or in Advance Settings within Signal Acquisition), which is convenient for current (voltage on shunt) measurements of non-periodic signals. The analog output level can be set for obtaining the curve for the Signal Acquisition measurement, as shown in Figure 5.

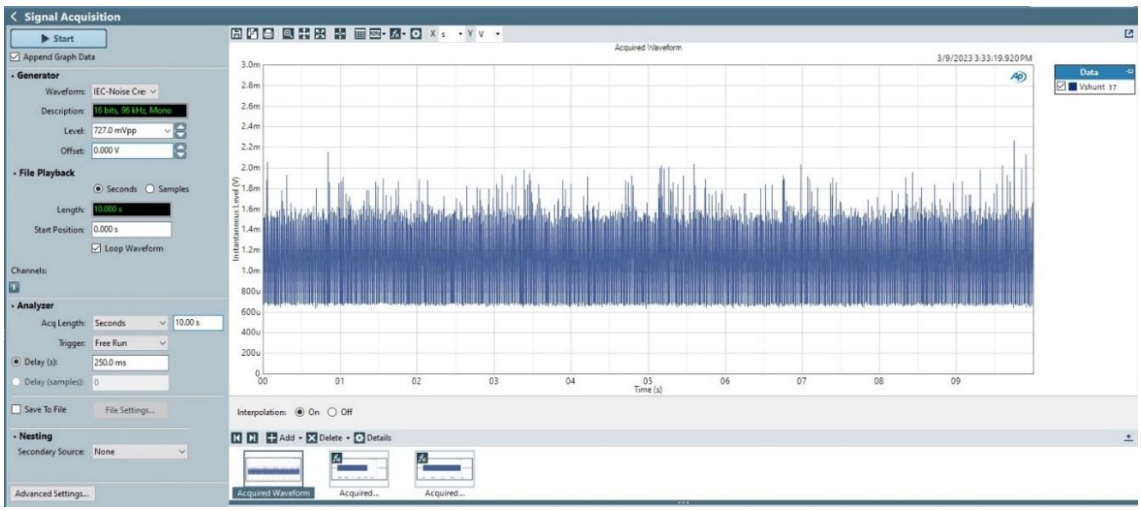


Figure 5. **Signal Acquisition waveform - current (voltage on shunt)**

It can be observed that the waveform is above 0 always, which indicates a DC component and a proper polarity in the setup of the balanced signal. In order to obtain a single value result that would determine the power consumption over time (the arithmetic mean or average value), the arithmetic mean value can be derived from the right-click menu on the acquired waveform, like inFigure 6.

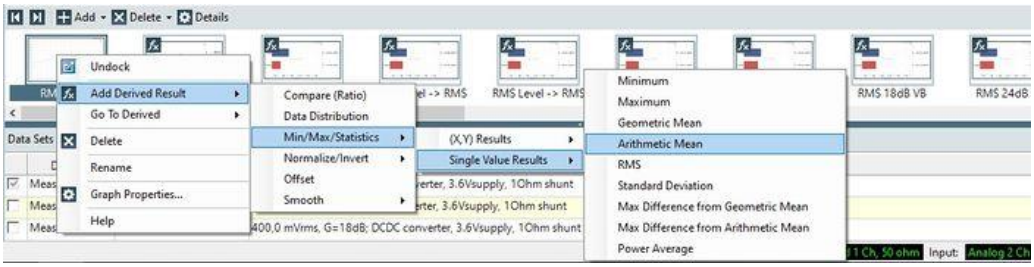


Figure 6. **Derived Result - Arithmetic Mean**

The Arithmetic Mean value for the current would then appear in a new window, as it is shown on Figure 7.

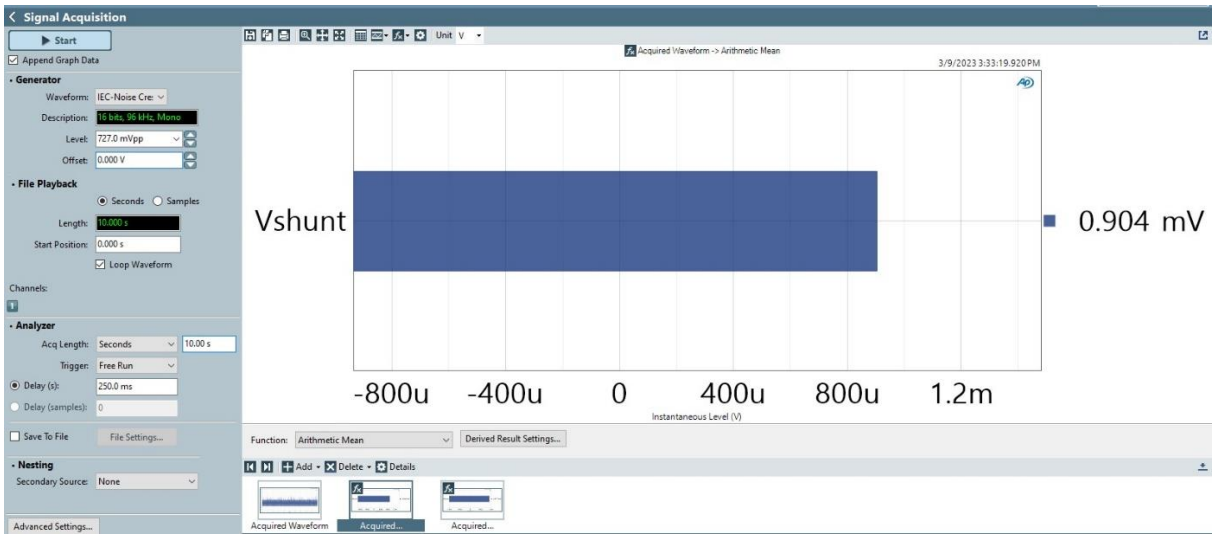


Figure 7. **Signal Acquisition - single value result arithmetic mean**

In this case the value of 0.904 mV, which equals 0.904 mA due to the 1Ω shunt, would be the final result of the measurement.

APPENDIX 2 – BILL OF MATERIAL

Designator	Description	Value	Manufacturer	Manufacturer Number	Fitted	Quantity
R7, R8, R12	0 Ohms Jumper 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Moisture Resistant Thick Film	0R	Yageo	RC0603JR-070RL	Fitted	3
C7, C10	0.1µF ±10% 10V Ceramic Capacitor X5R 0402 (1005 Metric)	100nF	Murata	GRM155R61A104KA01D	Fitted	2
L1	1 µH Unshielded Multilayer Inductor 900 mA 224mOhm Max 0603 (1608 Metric)	1uH	Taiyo Yuden	LSCNA1608FKT1R0MA	Fitted	1
R1, R2	1 MOhms ±1% 0.063W, 1/16W Chip Resistor 0402 (1005 Metric) Moisture Resistant Thick Film	1M	Yageo	RC0402FR-071ML	Fitted	2
TP1, TP2, TP3, TP4, TP5, TP6, TP7, TP8, TP9, TP10, TP11, TP12, TP13, TP14, TP16	1 Positions Header, Breakaway Connector Through Hole Tin		Molex	0901200121	Fitted	15
J12, J14, J16, J17	2 (1 x 2) Position Shunt Connector Black Open Top, Grip 0.100" (2.54mm) Gold 2 (1 x 2) Position Shunt Connector Black Open Top, Grip 0.100" (2.54mm) Gold		Würth Elektronik	609002115121	Fitted	4
J1, J2, J3, J7, J8, J9, J11, J15	2 Positions Header, Breakaway Connector 0.100" (2.54mm) Through Hole Tin		Molex	0901200122	Fitted	8
J13	3 Positions Header, Breakaway Connector 0.100" (2.54mm) Through Hole Tin		Molex	0901200123	Fitted	1
C1, C101	4.7 µF ±20% 25V Ceramic Capacitor X5S 0402 (1005 Metric)	4.7uF	Murata	GRM155C61E475ME15J	Fitted	2
R5, R6	4.7 kOhms ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	4k7	Stackpole Electronics Inc	RMCF0603FT4K70	Fitted	2

C8, C9	4.7µF ±10% 6.3V Ceramic Capacitor X7R 0603 (1608 Metric)	4.7uF	Samsung	CL10B475KQ8NQNC	Fitted	2
C4, C6	10 µF ±10% 50V Ceramic Capacitor X5R 0805 (2012 Metric)	10uF	Murata	GRM21BR61H106KE43L	Fitted	2
R9, R10	10 MOhms ±1% 0.125W, 1/8W Chip Resistor 0805 (2012 Metric) Automotive AEC-Q200 Thick Film	10M	Stackpole Electronics Inc.	RMCF0805FT10M0	Fitted	2
C2	22 µF ±20% 10V Ceramic Capacitor X5R 0805 (2012 Metric)	22uF	Murata Electronics	GRM21BR61A226ME51L	Fitted	1
R3, R4	47 Ohms ±1% 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Automotive AEC-Q200 Thick Film	47R	Stackpole Electronics Inc	RMCF0603FT47R0	Fitted	2
C5	100 µF ±20% 16V Ceramic Capacitor X5R 1210 (3225 metrisch)	100uF	Taiyo Yuden	EMK325ABJ107MM-T	Fitted	1
J4, J5	Connector Header Through Hole 2 position 0.100" (2.54mm)		Molex	0901200122	Fitted	2
J6, J10	Connector Header Through Hole 3 position 0.100" (2.54mm)		Molex	0901200123	Fitted	2
J18	Connector Header Through Hole 8 position 0.100" (2.54mm)		Würth Elektronik	61300811121	Fitted	1
D1	Diode Schottky 40 V 1A Surface Mount SOD-123W	40V	Nexperia USA Inc.	PMEG4010ER,115	Fitted	1
LS1, LS2	Fiducial marker				Fitted	2
U1	Mono, MEMS speaker driver with I2C control		USound	UC-P3010	Fitted	1
R11	0 Ohms Jumper 0.1W, 1/10W Chip Resistor 0603 (1608 Metric) Moisture Resistant Thick Film	0R	Yageo	RC0603JR-070RL	Not Fitted	0
C11	220 pF ±5% 50V Ceramic Capacitor C0G, NP0 0603 (1608 Metric)	22nF	Murata	GCM1885C1H221JA16D	Not Fitted	0
C100	150 pF ±5% 50V Ceramic Capacitor C0G, NP0 0402 (1005 Metric)	150pF	Murata	GCM1555C1H151JA16J	Fitted	1
R100	5.6 Ohms ±1% 0.063W, 1/16W Chip Resistor 0402 (1005 Metric) Moisture Resistant Thick Film	5R6	Yageo	RC0402FR-075R6L	Fitted	1

RELATED DOCUMENTATION

Tarvos 1.0 UC-P3010 Product Brief

Tarvos 1.0 UC-P3010 Preliminary Datasheet

COMPATIBLE PRODUCTS

Product Name	Description
Tarvos 1.0 UC-P3010	ASIC linear audio amplifier with analog input to drive the USound MEMS speakers
Carme kit 6 mm UJ-E1040C06	A speaker evaluation kit for testing acoustical performance of the USound MEMS speaker Conamara 6 mm.
Carme kit 5 mm UJ-E1040C05	A speaker evaluation kit for the testing acoustical performance of the USound MEMS speaker Conamara 5 mm.
Carme kit Ganymede UJ-E1040G00	A speaker evaluation kit for testing acoustical performance of the USound MEMS speaker Adap/Achelous.
Conamara UA-C0503-3T	MEMS speaker for 2-way speaker solution in wearables and hearables, tweeter, 5 mm diameter.
Conamara UA-C0603-3T	MEMS speaker for 2-way speaker solution in wearables and hearables, tweeter, 6 mm diameter
Conamara UA-C0603-3F	MEMS speaker for wearables and hearables, full bandwidth, 6 mm diameter.
Achelous UT-P2020	MEMS speaker for in-ear audio solution, hearables, full-bandwidth, rectangular (Ganymede sereis)
Achelous UT-P2016	MEMS speaker for in-ear audio solution, hearables, full-bandwidth, rectangular and plastic cover (Ganymede sereis)
Adap UT-P2023	MEMS speaker for free-field applications, rectangular (Ganymede sereis)

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