

# IA8201 EVM Kit Hardware User Guide



This document details the architecture and design of the IA8201-LT development kit, as well as the hardware implementation of the Knowles IA8201-RDI-01. The extension kit is the IA8201 Reference Design for IoT designed to work with the Raspberry Pi.



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## Chapter 1: Hardware Setup

### 1.1 Overview

The Knowles IA8201-RDI-01 Reference Design for IoT is IA8201CQ1 DSP-based, which is a dual core Digital Signal Processor (DSP) for audio processing designed to implement with a readily available Raspberry Pi board to achieve low power and compact design. The IA8201 supports wake-on-voice processing for low latency voice UI, noise reduction, context awareness, and accelerated machine learning inferencing for sensor inputs edge processing.



Figure 1

### 1.2 Setup

The IA8201-LT, when connected to a Raspberry Pi, is constantly listening for wake words and commands. Upon detection of correct keyword, to signal a wake word detection, the IA8201 sends an interrupt using the IRQ signal connected to a GPIO on the Raspberry Pi (GPIO-06). The Raspberry Pi will then begin recording audio and initiates appropriate actions.

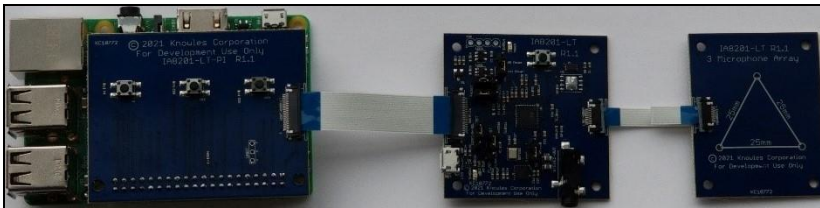


Figure 2: IA8201-LT Connected to a Raspberry Pi Development Board with a 3-microphone array board.

### 1.3 Hardware Components

This section details the hardware components of the following boards:

1. IA8201-LT DSP Board Components
2. IA8201-LT-Pi Adapter Board Components
3. IA8201-LT 3 Microphone Array Board Components
4. IA8201-LT 2 Microphone Array Board Components



### 1.3.1 IA8201-LT DSP Board Components

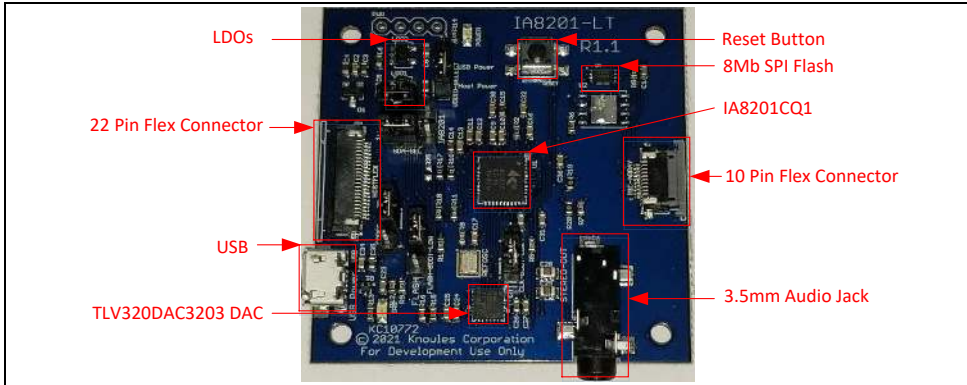


Figure 3: IA8201-LT DSP Board

### 1.3.2 IA8201-LT-Pi Adapter Board Components

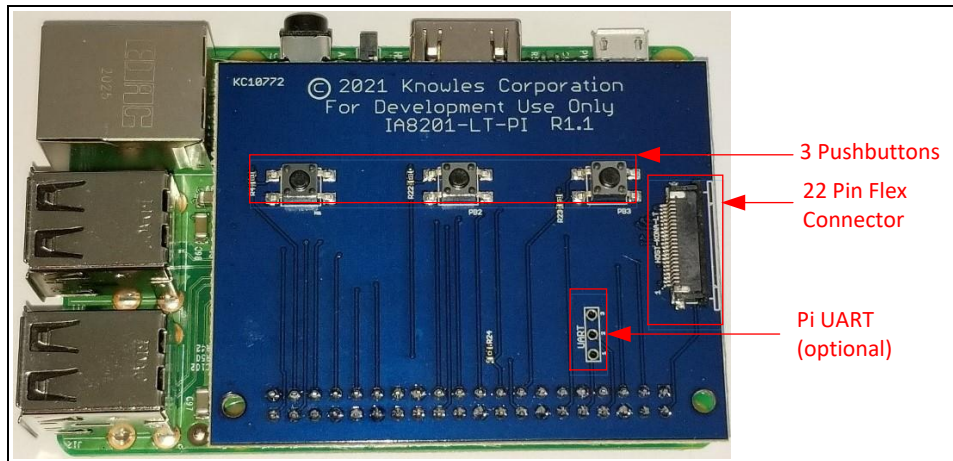


Figure 4: IA8201 Raspberry Pi Adapter Board connected to the Pi

### 1.3.3 IA8201-LT 3 Microphone Array Board Components

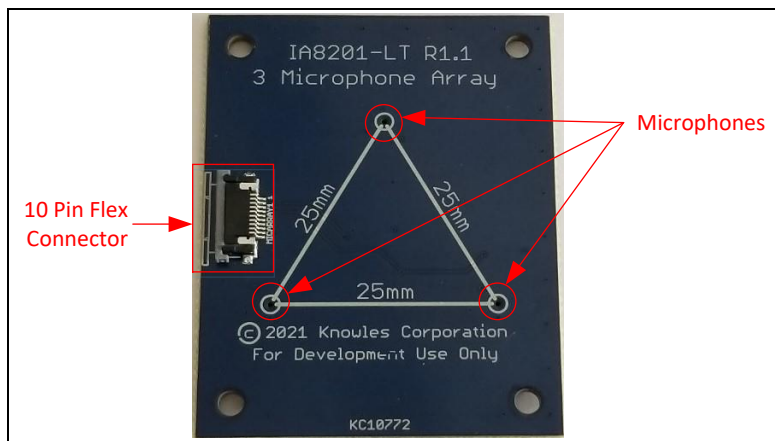
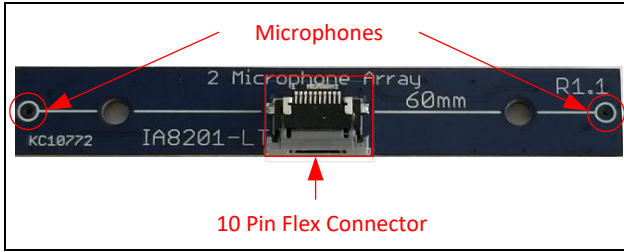


Figure 5: IA8201 3 Microphone Array Board

- Three Knowles SPH0690LM4H-1 Everest Microphones in a triangle pattern spaced 25mm apart.
- 10 Pin DSP Flex connector



### 1.3.4 IA8201-LT 2 Microphone Array Board Components



**Figure 6: IA8201 2 Microphone Array Board**

- 2 Knowles SPH0690LM4H-1 Everest Microphones spaced 60mm apart
- 10-pin DSP Flex connector



## Chapter 2: IA8201-RDI-01 Kit Hardware

The IA8201-LT development boards are part of the Knowles IA8201 Reference Design for IoT platform. These boards connect the IA8201 series of DSPs to low-cost microprocessors for IoT integration.

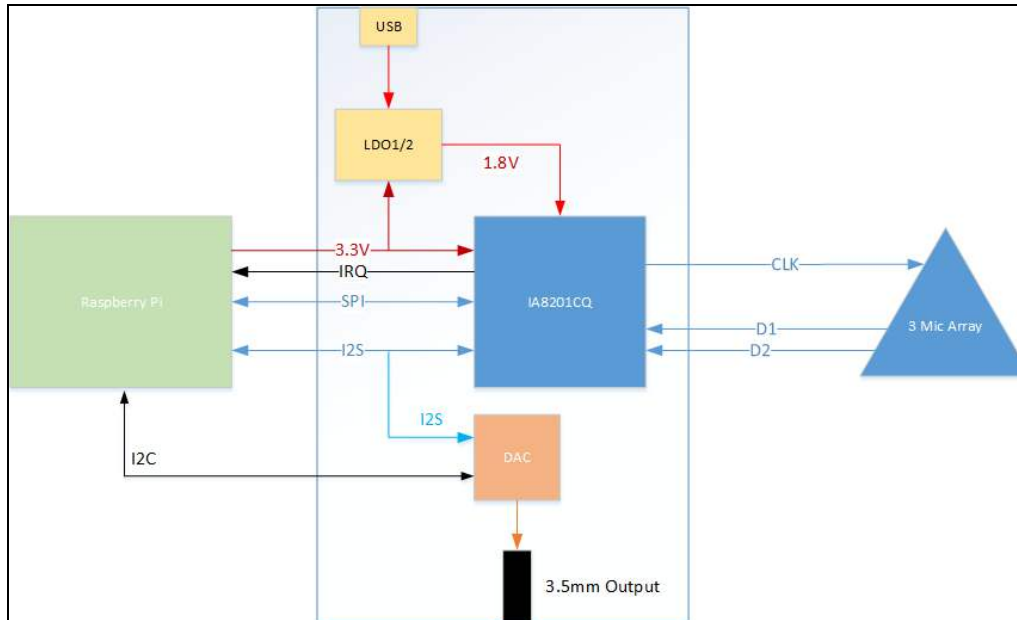


Figure 7: Basic Hardware Architecture for IA8201 Reference Design Kit for IoT using a Raspberry Pi

### 2.1 IA8201 Hardware Connection

Connect IA8201-LT DSP board through the 40-pin expansion connector on the Raspberry Pi. The necessary signals are fed to the IA8201LT Processor board through a 22-pin Flex cable. These signals include an SPI connection, an I2S connection, an I2C connection, 3.3V power, Ground, and various GPIOs. Connect the microphone array board on the opposite side of the DSP board, through a 10-pin flex connector that supplies the array boards with a microphone clock, power, and ground. The data from the microphones is routed from the array board to the DSP board through pre-configured lines.

#### 2.1.1 IA8201 Raspberry Pi Adapter Board

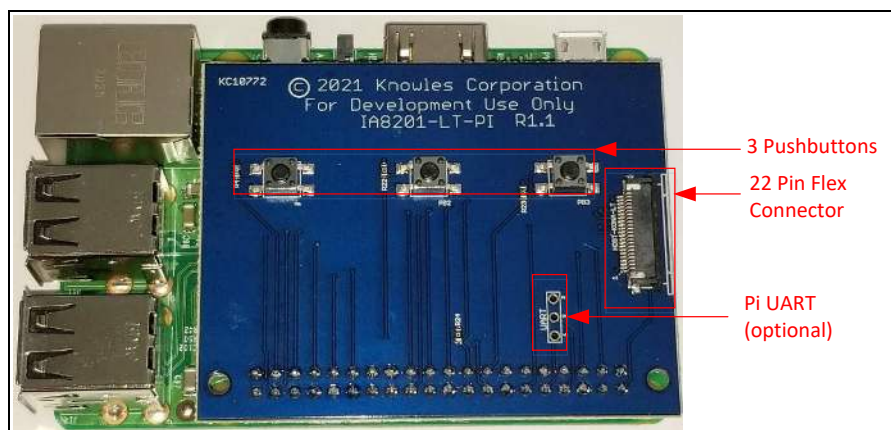


Figure 8: IA8201 Raspberry Pi Adapter Board connected to the Pi.



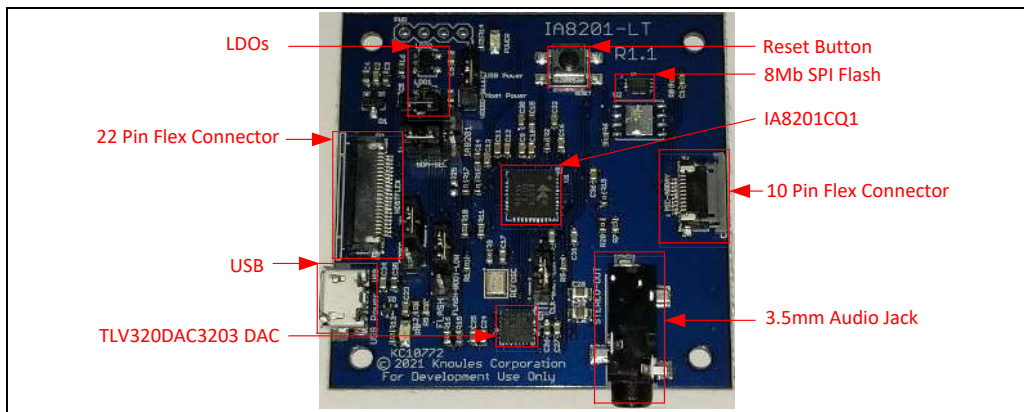
Use the Raspberry Pi's SPI port to program and control the IA8201. The Raspberry Pi's I2S is connected to both the IA8201 and the TI DAC for Audio output and input to the Pi. The I2C interface on the Raspberry Pi is only used to configure the TI DAC on the IA8201 Processor board.

For more information on specific programming and control details, see *IA8201 EVM Kit Software User Guide*.

Three GPIOs are connected between the Pi and the IA8201-LT Processor board to allow the Pi (CH-RST) to reset the IA8201, receive an IRQ (CH-IRQ) from the IA8201, and wake (WAKE) the processor from various sleep modes.

The Pi adapter board has three pushbuttons connected to GPIO26, GPIO23, and GPIO22. These buttons are intended to be used by the host application and do not directly connect to the IA8201LT DSP Board.

### 2.1.2 IA8201 LT DSP Board



**Figure 9: IA8201-LT DSP Board**

The IA8201 CQ requires a 1.8V reference voltage to generate the correct processor voltage for both DSPs, hence the IA8201LT DSP board includes a 1.8V LDO (LDO1) to generate this voltage for the IA8201's internal LDO.

The IA8201 LT DSP board includes a 19.2MHz oscillator to provide a time base and boot clock to the IA8201 CQ. The user can remove this time base, but the latch on reset pin to boot from the IA8201CQ from its internal oscillator must be modified using the CLK-BOOT-LOR jumper. To boot from an internal oscillator, the jumper must be moved from the default 3-2 position to the 1-2 position.

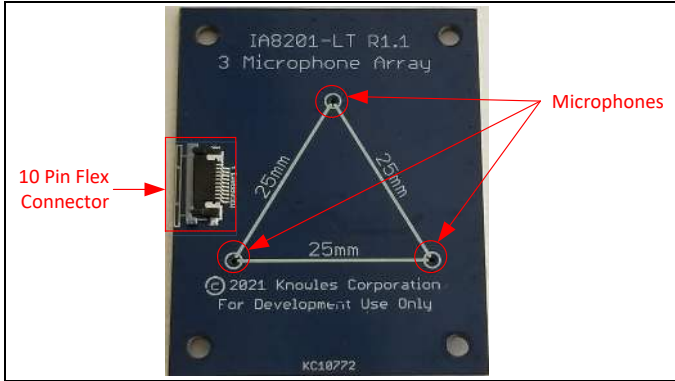
The IA8201 LT DSP board also includes two LEDs. The green LED indicates that the board is powered by 3.3V. The Red LED is connected to the IRQ pin through a FET to indicate when the IA8201 CQs interrupt pin becomes active. The IRQ pin is active at power up and remains so until the IA8201 CQ is programmed and operational.

In a host-less mode, the IA8201 LT DSP board and other components requires 3.3V to operate. A 3.3V LDO (LDO2) was used to power the board from the USB, independent of the Host 3.3V supply. When using the external USB power, Jumper VDDIO-SELECT must be moved to the USB position.

When configuring the IA8201 CQ to boot from flash, the latch on reset pin (GPIO1) must be configured using the FLASH-BOOT-LOR selector jumper. When booting from flash, move the jumper to position 2-3.



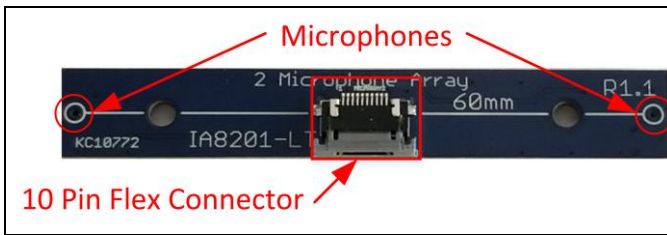
### 2.1.3 IA8201 LT 3 Microphone Array Board (Triangle)



**Figure 10: IA8201 3 Microphone Array Board**

The IA8210 LT 3 microphone array board includes three Knowles SPH0690 Everest microphones. Microphones 1 and 2 share a data line (D1), whereas Microphone 3 has its own data line (D2). The microphone array board includes a clock cleanup circuit that allows longer distance flex cables to be connected between the DSP board and the microphone array. The maximum recommended length of this cable is 20cm.

### 2.1.4 IA8201 LT 2 Microphone Array Board (Linear)



**Figure 11: IA8201 2 Microphone Array Board**

The IA8201 LT 2 microphone array board includes two Knowles SPH0690 Everest microphones, which share a data line (D1). This array, like the IA8201 LT3 microphone array board has a clock cleanup circuit that allows the microphones to be placed up to 20cm away from the DSP board.





# Chapter 3: Schematics

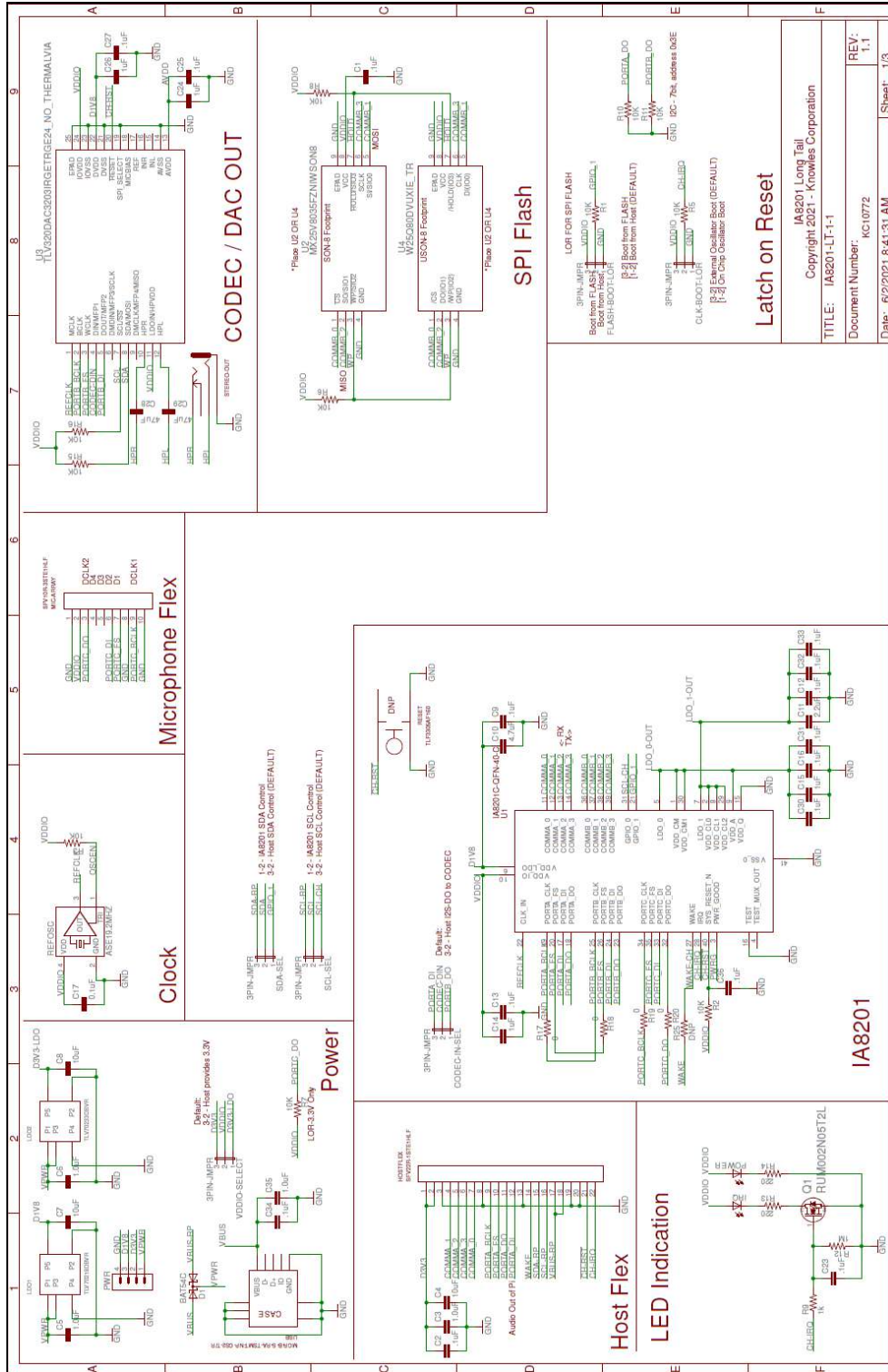
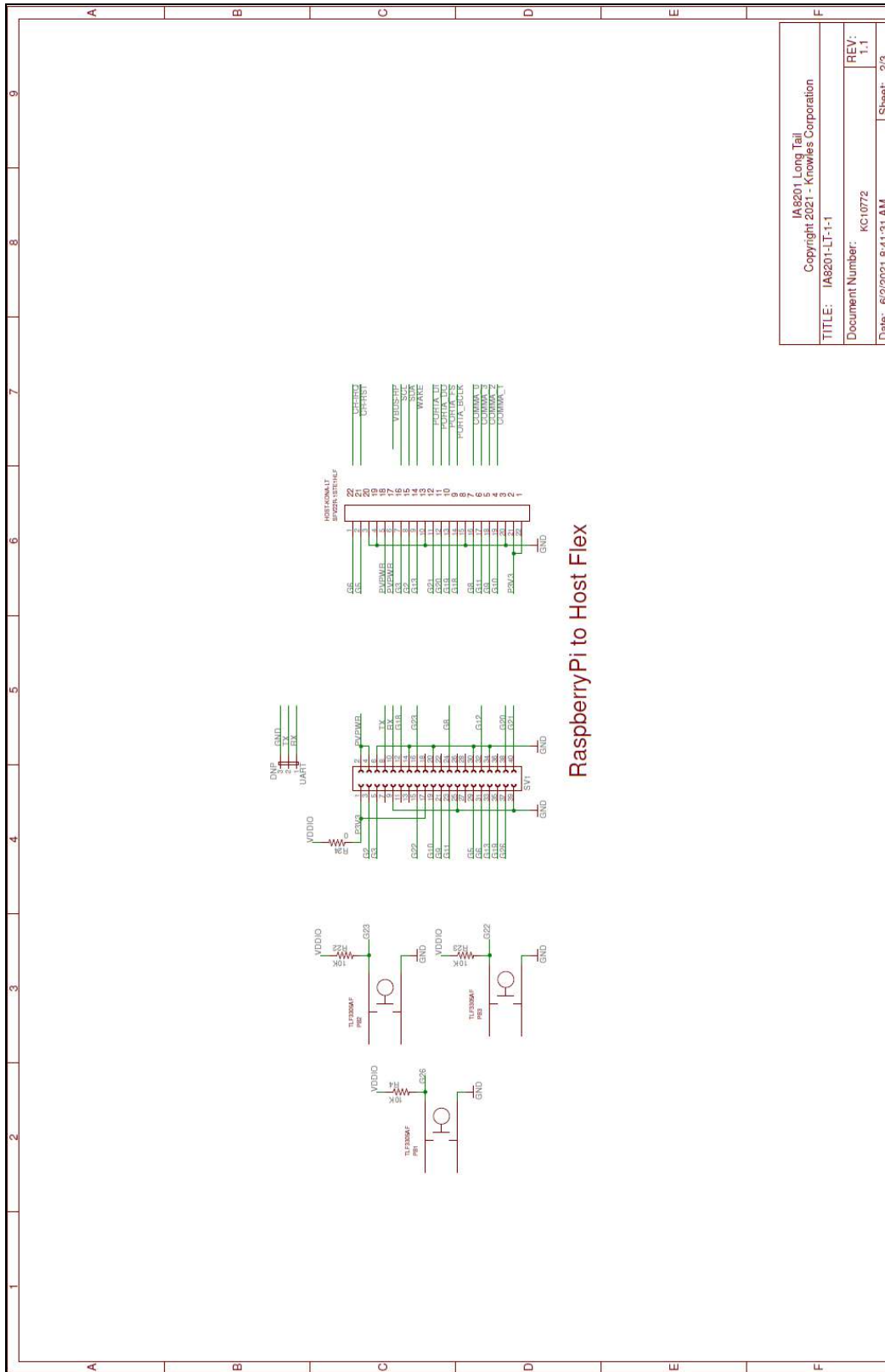


Figure 12: Schematic of the Knowles IA8201-LT DSP Board

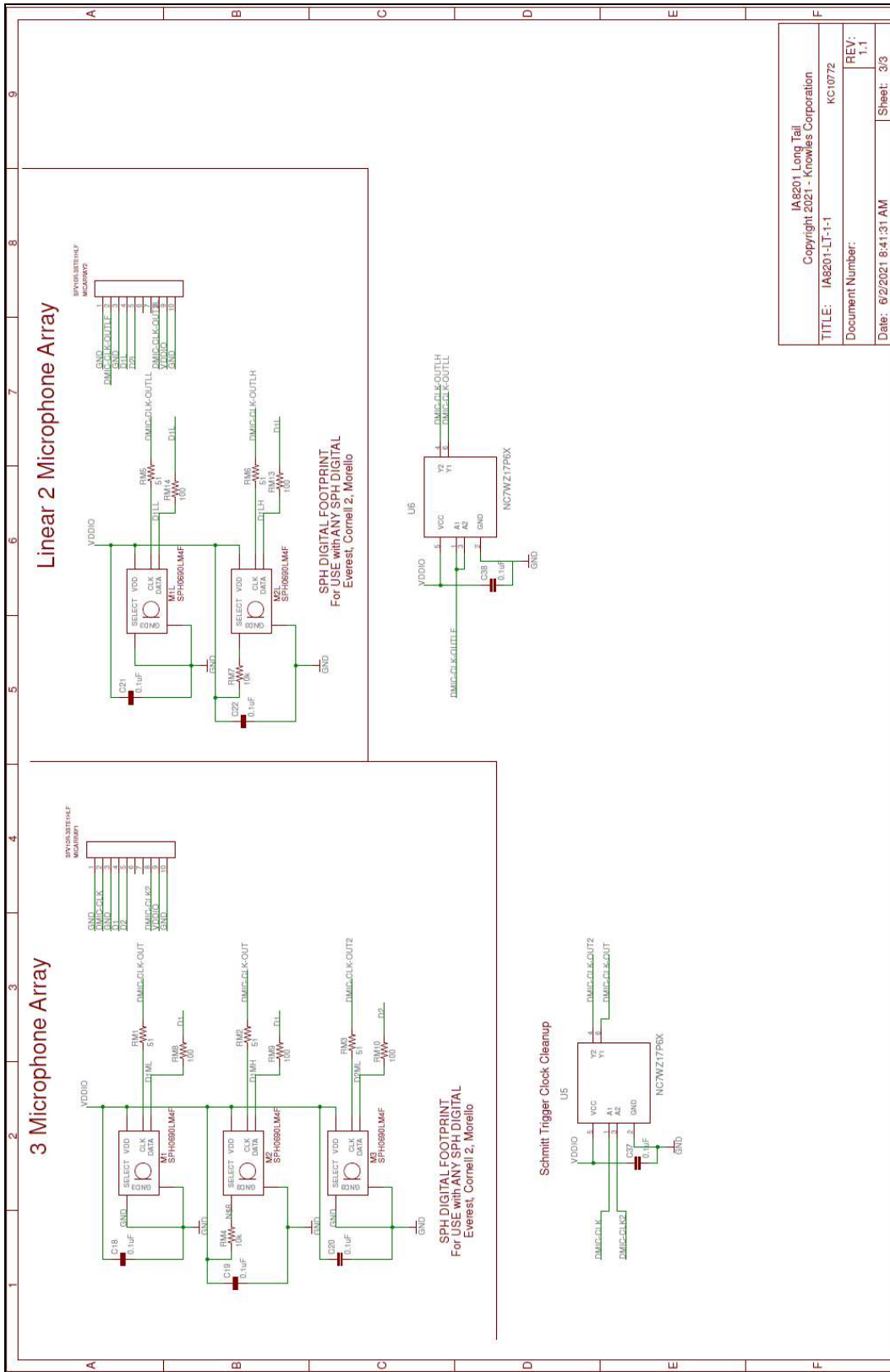




RaspberryPi to Host Flex

Figure 13: Schematic of the Knowles IA8201-LT Pi Adapter Board





IA8201 Long Tail	
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Figure 14: Schematic of the Knowles IA8201-LT Mic Array Boards



### 3.1 Bill of Materials

Ref Designator	Manufacturer	Manufacturer Part Number	Description
HOSTFLEX, HOST-KONA-LT	AMPHENOL FCI (VA)	SFV22R-1STE1HLF	CONN FFC BOTTOM 22POS 0.50MM R/A
MIC-ARRAY, MICARRAY1, MICARRAY2	AMPHENOL FCI (VA)	SFV10R-3STE1HLF	CONN FPC BOTTOM 10POS 0.50MM R/A
VDDIO-SELECT, SDA-SEL, SCL-SEL, CODEC-IN-SEL, FLASH-BOOT-LOR, CLK-BOOT-LOR	HARWIN INC	M20-9990346	CONN HEADER VERT 3POS 2.54MM
SV1	HARWIN INC	M20-7832046	CONN RCPT 40POS 0.1 TIN PCB
USB	ADAM TECH (VA)	MCR-B-S-RA-TSMT-NP-CS2-T/R	MICRO USB, TYPE B, RIGHT ANGLE,
STEREO-OUT	CUI DEVICES (VA)	SJ-3524-SMT-TR	CONN JACK STEREO 3.5MM SMD R/A
Placed in default locations	Sullins Connector Solutions	QPC02SXGN-RC	CONN JUMPER SHORTING .100" GOLD
FL1	Molex	0150200233	FFC, FPC Cable 0.020" (0.50mm) 4.000" (101.60mm)
FL2	Molex	0152660105	CABLE FFC 10POS 0.50MM 6"
SW1, SW2, SW3, RESET	E-SWITCH (VA)	TL3305AF160QG	SWITCH TACTILE SPST-NO 50MA 12V
R17,R18,R19,R20,R24	Yageo	RC0603JR-070RL	RES SMD 0 OHM JUMPER 1/10W 0603
RM1,RM2,RM3,RM5,RM6	Yageo	RC0603JR-0751RL	RES SMD 51 OHM 5% 1/10W 0603
R13,R14	Yageo	RC0603JR-07300RL	RES SMD 220 OHM 5% 1/10W 0603
RM8,RM9,RM10,RM13,RM14	Yageo	RC0603JR-07100RL	RES SMD 100 OHM 5% 1/10W 0603
R9,	Yageo	RC0603JR-071KL	RES SMD 1K OHM 5% 1/10W 0603
R1,R2,R3,R4,R5,R6,R7,R8,R10,R11,R15,R16,R22,R23,	Yageo	RC0603JR-0710KL	RES SMD 10K OHM 5% 1/10W 0603
R12	Yageo	RC0603JR-071ML	RES SMD 1M OHM 5% 1/10W 0603
C1,C2,C9,C12,C13,C16,C17,C18,C19,C20,C21,C22,C23,C25,C27,C30,C31,C32,C33,C34,C36,C37,C38	Samsung Electro-Mechanics	CL10F104ZB8NNNC	CAP CER 0.1UF 50V Y5V 0603



Ref Designator	Manufacturer	Manufacturer Part Number	Description
C3,C5,C6,C14,C15,C24,C26,C35	Samsung Electro-Mechanics	CL10B105KA8NFNC	CAP CER 1UF 25V X7R 0603
C11	Samsung Electro-Mechanics	CL10A225KP8NNNC	CAP CER 2.2UF 10V X5R 0603
C10	Samsung Electro-Mechanics	CL10A475MQ8NNNC	CAP CER 4.7UF 6.3V X5R 0603
C4,C7,C8	Samsung Electro-Mechanics	CL10A106KQ8NNWC	CAP CER 10UF 6.3V X5R 0603
C28, C29	Taiyo Yuden	JMK212BBJ476MG-T	CAP CER 47UF 6.3V X5R 0805
LDO2	TEXAS INSTRUMENTS	TLV70233PDBVT	IC REG LINEAR 3.3V 300MA SOT23-5
LDO1	TEXAS INSTRUMENTS	TLV70218PDBVT	IC REG LINEAR 1.8V 300MA SOT23-5
Q1	ROHM SEMICONDUCTOR (VA)	RUM002N05T2L	MOSFET N-CH 50V 200MA VMT3
D1	Infineon Technologies	BAT5405E6327HTSA1	DIODE ARRAY SCHOTTKY 30V SOT23
U5,U6	ON Semiconductor	NC7WZ17P6X	
REFOSC	TAITIEN USA	OXKTGLJANF-19.200000	XTAL OSC XO 19.2000MHZ CMOS SMD
IRQ	Würth Elektronik	150080SS75000	Red 630nm LED Indication - Discrete 1.9V 0805 (2012 Metric)
POWER	Würth Elektronik	150080GS75000	Green 520nm LED Indication - Discrete 3.2V 0805 (2012 Metric)
U4	Macronix	MX25V8035FZUI	IC FLASH 8MBIT SPI 104MHZ 8USON
U2	DNP		
U3	Texas Instruments	TLV320DAC3203IRGET	IC AMP CLASS AB STEREO 24VQFN
U1	Knowles Corporation	IA8201CQ-1	IA8201 DSP QFN
M1,M2,M3,ML1,ML2	Knowles Corporation	SPH0690LMH4H-1-1	Knowles Everest Microphone



## Revision History

Version	Comments	Date
1.0	Initial Release	7/16/2021
1.1	Updated part number	3/08/2021