

BUGG v2 Handover Report

July 23, 2021

1 Context

Building upon previous work, the main goal of the design presented herein is to produce a device that can constantly stream audio over the Internet to a remote server, is easily produced en masse, in quantities of 1000 or more, is easy to install and use by lay people, and is durable enough to withstand long periods deployed outdoors in rainforest conditions.

Monad Gottfried Ltd. divided the work into three work packages - WP1a and WP1b delivered prototype and production PCBA's respectively, and WP3 delivered an injection moulded enclosure.

2 WP1 Features Specified and Delivered

Specified	Delivered
Powered by DC 4-20V approx	Two inputs; 5V designed for USB connection, 5-30V flexible input for field deployment. Seamless automatic cross-over.
Raspberry Pi Compute SoM (CM3+) with eMMC (system storage on eMMC)	Raspberry Pi CM4 with eMMC
SD slot for external storage (config scripts + experiment data)	as specified
Reliable 3G/LTE connectivity	as specified
20Hz-20kHz microphone input, ported through housing	Extended bandwidth to 20Hz-80kHz to record bats, etc.
USB-connected audio ADC integrated onto PCBA	I2S bus used instead with I2S-PDM bridge IC
Robust brownout detect & recovery	Raspberry Pi's reset circuit is sufficient
On-board 3G/LTE module with SIM slot	as specified - Sierra Wireless RC7620 selected
Status LED's	as specified
Everything designed for eventual scalable production - 100's to 1000's	as specified - manual assembly steps simplified and minimised
Designed for operation at elevated temperature and humidity - >40°C, 100% humidity	as specified - mating surfaces gasketed, ePTFE microphone membrane, silica gel sachet
Piezo buzzer for general debug	omitted
External antenna via waterproof SMA connector	Internal antenna - more robust and similar performance

3 WP3 Features Specified and Delivered

Specified	Delivered
To meet IP66 with informal testing	IP66 not tested, due to unsuitable equipment. Failed IP67 (harsher) testing - after 60 min immersion at 1m, approx 1ml of water leaked. Rain (IP2-4) should be no problem. Humidity performance untested.
Tough, high-impact polymer - PC / PC-ABS.	Selected ABS Polyac PA-727; slightly better moulding performance, 3mm wall
Must withstand harsh environments - tropical rainforest etc. for up to 1 year.	Untested - not deployed yet
Waterproof, pressure-equalising microphone port (Goretex or similar).	Selected custom part from Voir. Goretex did not want to work with us
Opaque single colour design, low visibility - dark colour - blue-grey/black etc.	Selected light grey RAL 7035
Easy installation - mounting to tree with durable straps.	Keyhole slots for webbing straps or screws for versatile installation
Deliver IM tool for full-custom injection moulded parts for scaled production	Aluminium tools stored at ProtoLabs - durable enough for thousands of parts
Visually appealing	Diagonal split-line over top surface defines product identity
SD and SIM access without special tools	SIM/uSD door retained by stainless steel thumb screws
LED's visible from outside - [partially] transparent housing / lightpipes	Press-fit light pipes selected. LED brightness selected for low visual impact in dark environment
3	
Durable panel-mount power connector,	Selected robust, hermetically sealed, M12 panel-mount connector. Carries power and USB data.
Everything designed for scalable production - 100's to 1000's of units.	Post-moulding manual operations: fitting light pipes, M12 connector and fastening PCBs into place

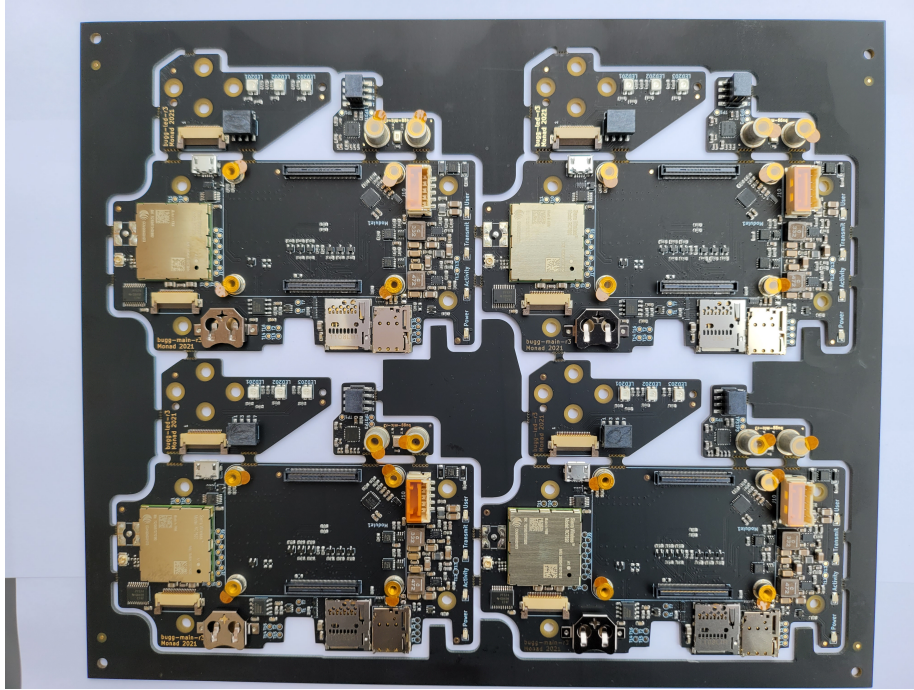


Figure 1: Production panel including four sub-panels

4 WP1 - PCBA Design Overview

4.1 PCBA Fabrication and Pick and Place Assembly

The BUGG product contains three custom PCBA's, called the *Main Board*, *LED Board* and the *Microphone Board*. To minimise PCB assembly cost, these three boards are grouped into one sub-panel, linked together with breakaway mouse-bites. This grouping allows all of the boards to be assembled in one go with a single paste stencil and Pick-and Place program. Further cost savings were achieved by designing all boards as single-sided loads. Multiple sub-panels can be combined into a production panel to optimise bare board cost and assembly through-put. For this production run, our assembly and fabrication providers recommended combining four sub-panels into one production panel. Ordering 20 production panels therefore provided us with enough sub-panels for 80 finished BUGG units. One assembled production panel can be seen in Figure 1.

In larger production runs it would likely make economic sense to make larger production panels with more sub-panels.