Test Certificate

An evaluation to assess the risk to human exposure for simultaneous operation had been performed by Element Materials Technology, on the following apparatus:

Equipment under test	LocoTrack Rechargeable
Applicant	System loco
Address	Parkfield Greaves Park Greaves Road Lancaster LA1 4TZ United Kingdom
Standards Used for Assessment	BS EN 62311:2020 / FCC KDB 447498 / RSS-102
Cellular Module Manufacturer	Quectel Wireless Solutions Company Limited
Type	BG95M3
Wi-Fi Module Manufacturer	Espressif Systems (SHANGHAI) Company Limited
Type	ESP-WROOM-02
Bluetooth	Integrated Bluetooth design

Test Certificate

EU Assessment of Simultaneous operation

Based on EN 62311:2003 section 8.3 Exposure field strengths for simultaneous transmissions can be compared to the reference levels on an rss basis using:

$$\sum_{i>1\,\mathrm{MHz}}^{300\,\mathrm{GHz}} \left(\frac{E_i}{E_{\mathrm{L},i}} \right)^2 \leq 1$$

Where
Ei = is the electric field strength at frequency *i*;
El'I = is the electric field reference level

Evaluation of Simultaneous operation of GSM 900 & Wi-Fi & BLE
0.92 ≤ 1 at a distance of 20 cm

Authorised by:

Digitally signed by John Charters
DN: cn=John Charters, o, ou=Element Materials Technology Ltd., email=john.charters@element.com, c=GB
Reason: I am approving this document
Date: 2021.06.17 14:58:18 +01'00'

John Charters
Department Manager - Radio

Certificate Issue Date: 17 June 2021
Authorised Copy No: PDF

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EU Simultaneous Operation Evaluation Information

Frequency Band Of operation (MHz)	Carrier Power (dBm)	Antenna Gain (dBi)	Measurement Distance (cm)	Field Strength at measurement distance (V/m)	Reference level (V/m)
GSM900	33	0	20.00	38.68	40.79
GSM1800	30	0	20.00	27.39	56.86
LTE Band 1	21	0	20.00	9.72	60.25
LTE Band 3	21	0	20.00	9.72	56.86
LTE band 8	21	0	20.00	9.72	40.79
LTE Band 20	21	0	20.00	9.72	39.66
LTE Band 28	21	0	20.00	9.72	36.46
BLE	-3.43	0	20.00	0.58	61.00
WiFi	19.98	0	20.00	8.64	61.00

Notes:- Cellular carrier power taken from Quectel_BG95-M3_CE(RED)_Certificate No:192140509/AA/01
Wi-Fi carrier power taken from Espressif Systems B2006165 RED Appendix Final.PDF
BLE Power measured as part of this assessment.

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FCC / ISED Assessment of Simultaneous operation

MPE Calculation

Prediction of MPE limit at a given distance

For purposes of these requirements mobile devices are defined by the FCC as transmitters designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between radiating structures and the body of the user or nearby persons. These devices are normally evaluated for exposure potential with relation to the MPE limits. As the 20 cm separation specified under FCC rules may not be achievable under normal operation of the EUT, an RF exposure calculation is needed to show the minimum distance required to be less than the power density limit, as required under FCC rules.

Equation from IEEE C95.1

$$S = \frac{EIRP}{4\pi R^2} \quad \text{re-arranged} \quad R = \sqrt{\frac{EIRP}{S4\pi}}$$

Where:

S = power density
R = distance to the centre of radiation of the antenna
EIRP = EUT Maximum power

Result

Radio	*Lowest frequency (MHz)*	*EIRP (mW)*	*Power density at 20 cm (mW/cm^2)*	*Power density limit (mW/cm^2)*	*Ratio*	*Sum of Ratios*	*Ratio Limit*
Cellular	824.2	1659.6	0.3302	0.5495	0.6009	0.618	PASS
Wi-Fi	2412	85.1	0.0169	1.0000	0.0169		
BLE	2402	0.3	0.0001	1.0000	0.0001		

Cellular power taken from equipment grant of authorisation for FCCID:XMR201910BG95M (Highest power)
Wi-Fi power taken from equipment grant of authorisation for FCCID:2AC7Z-ESPWROOM02D
BLE Power measured as part of this assessment.

Test Certificate

Frequency Band Of operation (MHz)	*EIRP (mW)*	Simultaneous Operation Combinations						
GSM850	1659.6	X						
GSM1900	993.5		X					
LTE Band 2	130.0			X				
LTE Band 3	130.0				X			
LTE Band 4	130.0					X		
LTE Band 5	124.7						X	
LTE Band 12	124.7							X
Wi-Fi	85.1	X	X	X	X	X	X	X
BLE	0.3	X	X	X	X	X	X	X