

September 30 2020

CalAmp
2200 Faraday Ave, Suite 220
Carlsbad, CA 92008
USA

Dear Imad Rizk,

Enclosed is the EMC Wireless test report for compliance testing of the CalAmp, TTU2830MB as tested to the requirements of the FCC Certification rules under Title 47 of the CFR Part 1 1.1310 RF Exposure.

Thank you for using the services of Eurofins E&E North America. If you have any questions regarding these results or if MET can be of further service to you, please contact me.

Sincerely yours,
EUROFINS E&E NORTH AMERICA

A handwritten signature in black ink, appearing to read "Arsalan Hasan".

Arsalan Hasan
Wireless Laboratory

Reference: (\CalAmp\WIRS109402-FCC-MPE Rev 5)



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Eurofins MET Laboratories Inc. (Eurofins E&E North America) is part of the Eurofins Electrical & Electronics (E&E) global compliance network.

Electromagnetic Compatibility Criteria Test Report

for the

**CalAmp
TTU2830MB**

**Tested under
FCC Certification Rules
Title 47 of the CFR, Part 1 1.1310**

Report: WIRS109402-FCC-MPE Rev 5

September 30, 2020

Prepared For:

**CalAmp
2200 Faraday Ave, Suite 220
Carlsbad, CA 92008
USA**

**Prepared By:
Eurofins E&E North America
3162 Belick St.
Santa Clara, CA 95054**

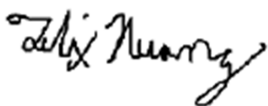
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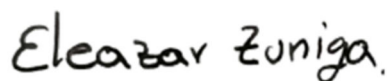


Felix Huang
Engineer, Wireless Laboratory



Arsalan Hasan
Manager, Wireless Laboratory

Engineering Statement: The measurements shown in this report were made in accordance with the procedures indicated, and the emissions from this equipment were found to be within the limits applicable. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment tested is capable of operation in accordance with the requirements of Part 1 of the FCC Rules under normal use and maintenance.



Eleazar Zuniga, PhD.
Director, Wireless Technologies

Report Status Sheet

Revision	Report Date	Reason for Revision
0	September 12, 2020	Initial Issue.
1	September 17, 2020	TCB Updates
2	September 21, 2020	TCB Updates
3	September 27, 2020	TCB Updates
4	September 29, 2020	TCB Updates
5	September 30, 2020	TCB Updates

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List of Terms and Abbreviations

AC	Alternating Current
ACF	Antenna Correction Factor
Cal	Calibration
<i>d</i>	Measurement Distance
dB	Decibels
dB μ A	Decibels above one micro amp
dB μ V	Decibels above one micro volt
dB μ A/m	Decibels above one micro amp per meter
dB μ V/m	Decibels above one micro volt per meter
DC	Direct Current
E	Electric Field
DSL	Digital Subscriber Line
ESD	Electrostatic Discharge
EUT	Equipment Under Test
<i>f</i>	Frequency
FCC	Federal Communications Commission
GRP	Ground Reference Plane
H	Magnetic Field
HCP	Horizontal Coupling Plane
Hz	Hertz
IEC	International Electrotechnical Commission
kHz	kilohertz
kPa	kilopascal
kV	kilovolt
LISN	Line Impedance Stabilization Network
MHz	Megahertz
μ H	micro henry
μ	micro farad
μ s	micro seconds
NEBS	Network Equipment-Building System
PRF	Pulse Repetition Frequency
RF	Radio Frequency
RMS	Root-Mean-Square
TWT	Traveling Wave Tube
V/m	Volts per meter
VCP	Vertical Coupling Plane

I. Executive Summary

A. Purpose of Test

An EMC evaluation was performed to determine compliance of the CalAmp TTU2830MB, with the requirements of Part 1. All references are to the most current version of Title 47 of the Code of Federal Regulations in effect. In accordance with §2.1033, the following data is presented in support of the Certification of the TTU2830MB. CalAmp should retain a copy of this document which should be kept on file for at least two years after the manufacturing of the TTU2830MB, has been **permanently** discontinued.

B. Executive Summary

The following tests were conducted on a sample of the equipment for the purpose of demonstrating compliance with Part 1, in accordance with CalAmp, purchase order number 401701.

Reference	Description	Compliance
§1.1310	RF Exposure	Compliant

Table 1. Executive Summary of EMC Compliance Testing

II. Equipment Configuration

A. Overview

Eurofins E&E North America was contracted by CalAmp to perform testing on the TTU2830MB, under CalAmp's purchase order number 401701.

This document describes the test setups, test methods, required test equipment, and the test limit criteria used to perform compliance testing of the CalAmp, TTU2830MB.

The results obtained relate only to the item(s) tested.

Model(s) Tested:	TTU2830MB	
Model(s) Covered:	TTU2830MB	
Filing Status:	Original	
EUT Specifications:	Primary Power: 12VDC	
	FCC ID: APV-2830MB	
	Module Original Report Number(s): RXA1706-0199MPE	
	Type of Modulations:	GFSK, BPSK, QPSK, 16QAM
	Equipment Code:	DTS, PCB
	Technology	TX Frequency Range
	GSM 850	824 – 849 MHz
	GSM 1900	1850 – 1910 MHz
	LTE CAT-M1 Band 2	1850 – 1910 MHz
	LTE CAT-M1 Band 4	1710 – 1755 MHz
	LTE CAT-M1 Band 5	824 – 849 MHz
	LTE CAT-M1 Band 12	699 – 716 MHz
	LTE CAT-M1 Band 13	777 – 787 MHz
	LTE CAT-M1 Band 25	1850 – 1915 MHz
	BLE	2402 – 2480 MHz
Analysis:	The results obtained relate only to the item(s) tested.	
Environmental Test Conditions:	Temperature: 15-35° C	
	Relative Humidity: 30-60%	
	Barometric Pressure: 860-1060 mbar	
Evaluated by:	Arsalan Hasan	
Date(s):	September 30, 2020	

Table 2. EUT Summary Table

B. References

CFR 47, Part 22, Subpart H	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 22: Rules and Regulations for Cellular Devices.
CFR 47, Part 24, Subpart E	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 24: Rules and Regulations for Personal Communications Services
CFR 47, Part 27	Federal Communication Commission, Code of Federal Regulations, Title 47, Part 27: Rules and Regulations for Advanced Wireless Services
KDB 996369 D04	Modular Transmitter Integration Guide – Guidance For Host Product Manufacturers
ANSI C63.4:2014	Methods and Measurements of Radio-Noise Emissions from Low-Voltage Electrical And Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.26: 2015	Compliance Testing of Transmitters Used in Licensed Radio Services
ISO/IEC 17025:2017	General Requirements for the Competence of Testing and Calibration Laboratories
EIA/TIA-603-A-2001	Land Mobile FM or PM Communication Equipment Measurement and Performance Standards
KDB 971168 v02r02	Measurement Guidance For Certification Of Licensed Digital Transmitters

Table 3. Standard References

C. Test Site

All testing was performed at Eurofins E&E North America, 3162 Belick St, Santa Clara, CA 95054. All equipment used in making physical determinations is accurate and bears recent traceability to the National Institute of Standards and Technology.

Radiated Emissions measurements were performed in a 10 meter semi-anechoic chamber (equivalent to an Open Area Test Site). In accordance with §2.948(a)(3), a complete site description is contained at Eurofins E&E North America.

Eurofins E&E North America is a ISO/IEC 17025 accredited site by A2LA, California #0591.02.

D. Measurement Uncertainty

Test Method	Typical Expanded Uncertainty (dB)	K	Confidence Level
Radiated Emissions, (30 MHz – 1 GHz)	±3.24	2	95%
Radiated Emissions, (1 - 6 GHz)	±3.92	2	95%
Conducted Emission	±3.53	2	95%
CEV Telecom Port	±2.44	2	95%

Table 4. Uncertainty Calculations Summary

E. Description of Test Sample

The CalAmp TTU2830MB is a vehicle tracking device using LTE connectivity and GPS for fleet management.



Figure 1: Block Diagram of Test Configuration

F. Equipment Configuration

Ref. ID	Slot #	Name / Description	Model Number	Part Number	Serial Number	Revision
1		Asset Tracker	TTU2830MB	TTU2830MB	4672001045	1

Table 5: Equipment Configuration

G. Support Equipment

Support equipment necessary for the operation and testing of the EUT is included in the following list.

Ref. ID	Name / Description	Manufacturer	Model Number	*Customer Supplied Calibration Data
3	Serial Adaptor	CalAmp	134364-SER	NA
4	Laptop	Dell	Latitude	NA

Table 6: Support Equipment

H. Ports and Cabling Information

Ref. ID	Port name on EUT	Cable Description or reason for no cable	Qty	Length as tested (m)	Max Length (m)	Shielded? (Y/N)	Termination Box ID & Port Name
2	Power/Data Port	12 wire BUS	1	1m	1m	n	na

Table 7: Ports and Cabling Information

I. Mode of Operation During Testing

The TTU2830MB was paired with CMW500 and the callbox on screen indication was used to monitor proper connection.

J. Method of Monitoring EUT Operation

The signal will be displayed on a spectrum analyzer.

K. Modifications

a) Modifications to EUT

No modifications were made to the EUT.

b) Modifications to Test Standard

No modifications were made to the test standard.

L. Disposition of EUT

The test sample including all support equipment submitted to the Electro-Magnetic Compatibility Lab for testing was returned to CalAmp upon completion of testing.

III. Electromagnetic Compatibility Criteria for Intentional Radiators

Maximum Permissible Exposure

RF Exposure Requirements: §1.1307(b)(1) and §1.1307(b)(2): Systems operating under the provisions of this section shall be operated in a manner that ensures that the public is not exposed to radio frequency energy levels in excess of the Commission's guidelines.

RF Radiation Exposure Limit: §1.1310: As specified in this section, the Maximum Permissible Exposure (MPE) Limit shall be used to evaluate the environmental impact of human exposure to radiofrequency (RF) radiation as specified in Sec. 1.1307(b), except in the case of portable devices which shall be evaluated according to the provisions of Sec. 2.1093 of this chapter.

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm ²)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3-3.0	614	1.63	*(100)	≤6
3.0-30	1842/f	4.89/f	*(900/f ²)	<6
30-300	61.4	0.163	1.0	<6
300-1,500			f/300	<6
1,500-100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3-1.34	614	1.63	*(100)	<30
1.34-30	824/f	2.19/f	*(180/f ²)	<30
30-300	27.5	0.073	0.2	<30
300-1,500			f/1500	<30
1,500-100,000			1.0	<30

Table 8. RF Exposure Limits

$$S = PG / 4\pi R^2 \quad \text{or} \quad R = \sqrt{PG / 4\pi S}$$

where, S = Power Density (mW/cm²)
P = Power Input to antenna (mW)
G = Antenna Gain (numeric value)
R = Distance (cm)

For Antenna Gain → dBi = 10log(Numeric)

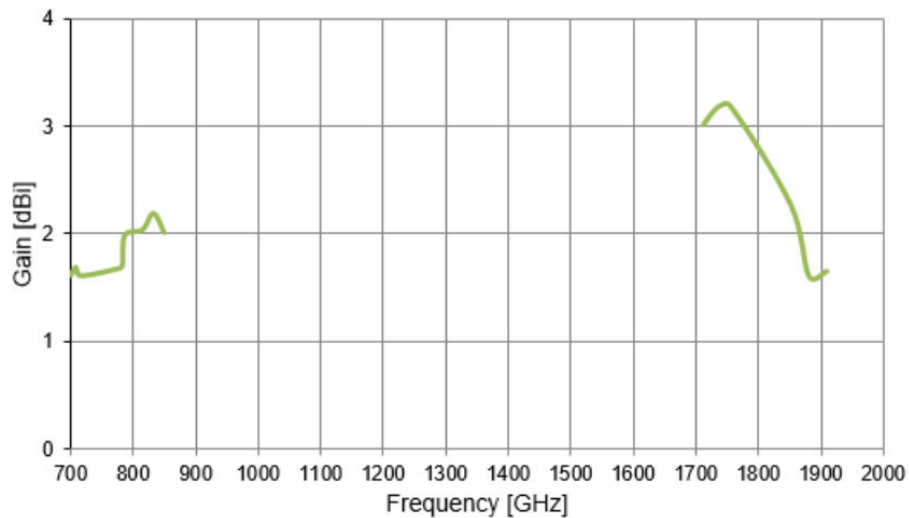


Figure 2: Antenna Peak Gain

Technology	TX Frequency Range (MHz)	Peak Gain (dBi)	Type
GSM 850	824 – 849	2.3	PCB Trace
GSM 1900	1850 – 1910	2.2	PCB Trace
LTE CAT-M1 Band 2	1850 – 1910	2.2	PCB Trace
LTE CAT-M1 Band 4	1710 – 1755	3.3	PCB Trace
LTE CAT-M1 Band 5	824 – 849	2.3	PCB Trace
LTE CAT-M1 Band 12	699 – 716	1.7	PCB Trace
LTE CAT-M1 Band 13	777 – 787	1.7	PCB Trace
LTE CAT-M1 Band 25	1850 – 1915	2.2	PCB Trace
BLE	2402 – 2480	1.88	Ceramic

Table 9. EUT Antenna Gain Specification

Technology	TX Frequency Range (MHz)	Time-average maximum tune-up procedure (dBm)	Division Factor (dB)	Frame-Average Power (dBm)
GSM 850	824 – 849	32 (-3 ~ +1dB)	-9.03	23.97
GSM 1900	1850 – 1910	29 (-3 ~ +1dB)	-9.03	20.97

Table 10. Tune up Power

Technology	TX Frequency Range (MHz)	Maximum Conducted Output Power (dBm)
GSM 850	824 – 849	23.97
GSM 1900	1850 – 1910	20.97
LTE CAT-M1 Band 2	1850 – 1910	23 (-3 ~ +1dB) = 24
LTE CAT-M1 Band 4	1710 – 1755	22 (-3 ~ +1dB) = 23
LTE CAT-M1 Band 5	824 – 849	23 (-3 ~ +1dB) = 24
LTE CAT-M1 Band 12	699 – 716	23 (-3 ~ +1dB) = 24
LTE CAT-M1 Band 13	777 – 787	23 (-3 ~ +1dB) = 24
LTE CAT-M1 Band 25	1850 – 1915	24 (-3 ~ +1dB) = 25
BLE	2402 – 2480	3 (-1 ~ +1dB) = 4

Table 11. Tune up Power

Bands covered under FCC Part 22 / FCC Part 24

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm ²)	Limit (mW/cm ²)	Margin	Distance (cm)	Result
GSM 850	848.8	23.97	249.45	2.3	1.698	0.084	0.565	-0.481	20	Pass
GSM 1900	1850.2	20.97	125.02	2.2	1.659	0.041	1	-0.958	20	Pass
LTE Band 2	1905.0	24	251.18	2.2	1.659	0.082	1	-0.917	20	Pass
LTE Band 5	829.0	24	251.18	2.3	1.698	0.085	0.552	-0.467	20	Pass
LTE Band 25	1910.0	25	316.22	2.2	1.659	0.104	1	-0.896	20	Pass

Table 12. MPE Calculation for Bands under Part 22 and Part 24

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Bands covered under FCC Part 27

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm ²)	Limit (mW/cm ²)	Margin	Distance (cm)	Result
LTE Band 4	1750	23	199.52	3.3	2.137	0.084	1	-0.915	20	Pass
LTE Band 12	711.0	24	251.18	1.7	1.479	0.074	0.474	-0.400	20	Pass
LTE Band 13	782.0	24	251.18	1.7	1.479	0.074	0.521	-0.447	20	Pass

Table 13 MPE Calculation for Bands under Part 27

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Bands covered under FCC Part 15.247

Test Results:

Band	Frequency (MHz)	Maximum Conducted Power (dBm)	Conducted Power (mW)	Antenna Gain (dBi)	Antenna Gain (Numeric)	Power Density (mW/cm ²)	Limit (mW/cm ²)	Margin	Distance (cm)	Result
BLE	2402	4	2.51	1.88	1.541	0.00077	1	-0.9992	20	Pass

Table 14. MPE Calculation for Bands under Part 15.247

The safe distance where Power Density is less than the MPE limit listed above was found to be 20 cm.

Note: Results are based on KDB 447498 D01 (Section 7.2) Transmitters used in mobile devices exposure conditions for simultaneous transmission operations.

Simultaneous transmission MPE test exclusion applies when the sum of the MPE ratios for all simultaneously transmitting antennas incorporated in a host device is ≤ 1.0 , according to calculated/estimated, numerically modeled, or measured field strengths or power density. The MPE ratio of each antenna is determined at the minimum test separation distance required by the operating configurations and exposure conditions of the host device, according to the ratio of field strengths or power density to the MPE limit at the test frequency.

Both BLE and Cellular can transmit simultaneously, the formula for calculating the simultaneous MPE is

$$\text{CPD1/LPD1} + \text{CPD2/LPD2} + \dots, \text{CPDn/LPDn} < 1$$

CPD: Calculated Power Density

LPD: Limit of Power Density

Therefore worst case scenario is as below:

$$\begin{aligned}\text{Simultaneous MPE} &= 0.074/0.474 + 0.00077/1 \\ &= 0.15611 + 0.00077 \\ &= 0.15688\end{aligned}$$

Result: $0.15688 < 1$ (Pass)

IV. Test Equipment

Test Equipment

Calibrated test equipment utilized during testing was maintained in a current state of calibration per the requirements of ISO/IEC 17025:2017.

Asset #	Equipment	Manufacturer	Model	Last Cal Date	Cal Due Date
1S4075	RADIO COMMUNICATION TESTER	ROHDE & SCHWARZ	CMW500	09/18/2018	09/18/2020
1S2399	TURNTABLE/MAST CONTROLLER	SUNOL SCIENCES	SC99V	SEE NOTE 1	
1S2600	BILOG ANTENNA	TESEQ	CBL6112D	03/19/2019	03/19/2021
1S2733	BILOG ANTENNA	TESEQ	CBL6112D	06/05/2019	06/05/2021
1S3826	DRG HORN ANTENNA	ETS-LINDGREN	3117	12/03/2018	12/03/2020
1S2198	DRG HORN ANTENNA	ETS-LINDGREN	3117	10/07/2019	10/07/2021
1S2000	SPECTRUM ANALYZER	AGILENT	E4448A	11/06/2019	11/06/2020
1S2587	PRE AMPLIFIER	AML COMMUNICATIONS	AML0126L3801	SEE NOTE 1	
1S2653	AMPLIFIER	SONOMA INSTRUMENT	310 N	SEE NOTE 1	
1S2486	5 METER CHAMBER	PANASHIELD - ETS	5M	SEE NOTE 2	
1S3824	SIGNAL GENERATOR	ROHDE & SCHWARZ	SMA100B	11/06/2019	05/06/2021

Table 13. Test Equipment List

Note 1: Functionally tested equipment is verified using calibrated instrumentation at the time of testing.

Note 2: Latest NSA and VSWR data available upon request.

End of Report