COMPLIANCE TESTING REPORT
FCC TITLE 47 PART 15
SUBPARTS A & C

Client:	Smartcap Technologies
Address:	1/18 Finchley Street, Milton, QLD 4064, Australia
Report Number:	1221HYD_Lifeband_FCC15C *(replaces report 1128HYD_Lifeband_FCC15C)*
Date of Testing:	2nd November 2016 to 20th February 2017 8th and 22nd November 2017
File Number:	HYD160527-B
Equipment Name:	LifeBand
Equipment Model Number	820-00008
Equipment Serial Number	Not Supplied
Equipment FCC ID:	2AD5S-LB01
Equipment Description:	LifeBand is a wearable EEG sensor for wellness applications with BLE radio communication
Result:	**COMPLIES**
Tested by	Joel Mulig Test Engineer
	Ron Leung Test Engineer
	Richard Turner Test Engineer
Approved by:	Colin Gan Assessment Engineer
Date of Issue:	21st December 2017

AUSTEST (NSW) FCC REGISTRATION NUMBER 90455

Results appearing herein relate only to the sample(s) tested.

This report is issued errors and omissions exempt and is subject to withdrawal at Austest Laboratories discretion.

This report is issued within the scope of A2LA accreditation #2765.02.

Accredited for compliance with ISO / IEC 17025.
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TEST LABORATORY
CERT #2765.02

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Report Revision History:

Date	Report Number	Changes
25/10/2017	1025HYD_LifeBand_FCC15C	Original report.
28/11/2017	1128HYD_Lifeband_FCC15C	Inclusion of radiated emission plots and duty cycle measurement
21/12/2017	1221HYD_Lifeband_FCC15C	Inclusion of tabulated data (p.17) for radiated emission measurements.

1 TEST SUMMARY

Austest makes no claim regarding the consistency of production versions of the EUT.

The results in this report apply only to the tested EUT described in Section 4 of this report.

FCC Section	Test	Result	Notes
FCC Part 15, Subpart C – Intentional Radiators			
15.203	Antenna Requirement	COMPLIES	
15.205	Restricted Bands of Operation	COMPLIES	
15.207	Conducted Limits	COMPLIES	
15.209	Radiated Emission Limits, General Requirements	COMPLIES	
15.215	Additional Provisions to the General Radiated Limitations	COMPLIES	
15.247	Operation within the Bands 902-928MHz, 2400-2483.5MHz, and 5725-5850MHz	COMPLIES	

2 MODIFICATIONS

No modifications were required to achieve compliance.

3 REFERENCES

FCC Title47 Part 15 current as of February 2017
ANSI C63.10: 2013
KDB Publication 558074 D01 DTS Meas Guidance v03r05, 08/04/2016

4 EQUIPMENT UNDER TEST (EUT) DESCRIPTION

EUT Name:	LifeBand
EUT Description:	LifeBand is a wearable EEG sensor for wellness applications with BLE radio communication
EUT Model:	820-00008
EUT Serial Number:	Not Supplied
EUT FCC ID:	2AD5S-LB01
Manufacturer:	Smartcap Technologies
Power Supply & Rating:	Internal battery: 4.35VDC External charger: 100-240VDC 50/60Hz 0.2A
Highest Clock/Operating Frequency:	Highest internal clock frequency: - 48MHz Highest possible operating frequency ~2480MHz (BLE)
Lowest Internal Frequency source	32kHz clock
Transmit Frequency Range:	BLE: 2402MHz to 2480MHz
Transmit Power:	BLE: -6.3dBm
Modulation Technique:	BLE: GFSK
Number of Channels:	BLE: 40 Channels
Antenna Specifications:	TDK multilayer chip antenna ANT016008LCS2442MA2 Maximum gain: 2.5dBi @ 2442MHz.

The equipment under test (EUT) is a fatigue management system tool for vehicle drivers or operators of heavy equipment. The EUT is battery powered and communicates via BLE (Bluetooth Low Energy) to a phone or other device. Additional data can be downloaded via the custom magnetic USB connector. A switch-mode power adaptor provides charging of the internal battery.

The client advised that the unit only communicates using BLE. Classic Bluetooth (frequency hopping using 79 channels) is not used.

Derived Models:

No other model variants to be included under the same FCC ID: 2AD5S-LB01.

5 EUT TEST SETUP & CONFIGURATION

Refer to the photographs in APPENDIX C – EUT TEST SETUP PHOTOGRAPHS for the EUT test setup and physical configuration.

The following cables and auxiliary equipment as supplied by the client were used:

Connection / Port	Connecting Cable	Source / Load
USB/External Power	Supplied 50cm long shielded USB cable	Test PC or supplied switch-mode AC adaptor

For measurements made at the output of the transmitter (under FCC Title 47 section 15.247), the client supplied a test box in which was placed the 5 EEG sensor array and PCB. The PCB was modified with chip antenna removed and external 50Ω coaxial RF output fitted. The test box also provided external battery and USB connection.

To enable control of the BLE transmission, the EUT was connected to a supplied test PC (Acer ES-511 series). Using instructions provided by the client, constant BLE transmission on selected low, middle and high channels was made. No control of transmit power was provided.

The EUT was within its allowed temperature and humidity range.

For charging purposes, the EUT was provided with a CUI INC switching adaptor, model SM15-5-V438, input 100-240VAC 50/60Hz 0.2A, output 5VDC 1A. The EUT BLE transmission can be enabled whilst battery charging is in progress.

Both the test PC (via AC adaptor) and switching adaptor were connected to the 115VAC 60Hz mains supply, provided by the AC source

5.1 EUT Operating Modes

Mode No.	Operating Mode Description
1	Constant BLE transmission (duty cycle 67%) on Ch0 (2402MHz). Test command “rftest tx 0”
2	Constant BLE transmission (duty cycle 67%) on Ch19 (2440MHz). Test command “rftest tx 19”
3	Constant BLE transmission (duty cycle 67%) on Ch39 (2480MHz). Test command “rftest tx 39”

6 TEST SPECIFICATIONS

6.1 Accreditations & Listings

Austest Laboratories has been found to be in compliance with the requirements of Section 2.948 of the FCC Rules and Test Site Criteria (ANSI C63.4-2014) by the FCC Laboratory Division for Certification testing under Parts 15 or 18 of the FCC Rules.

Austest Laboratories (NSW)'s Castle Hill and Yarramalong test facilities are accredited by A2LA. The tests reported herein have been performed in accordance with its terms of accreditation.

6.2 Deviations from Standards and/or Accreditations

None.

6.3 Test Facility

Testing was performed at the following locations:

- Austest Laboratories, 2/9 Packard Avenue, Castle Hill, NSW 2154, Australia
- Austest Laboratories, 46 Glenola Farm Lane, Yarramalong, NSW 2259, Australia

Radiated emissions testing above 30MHz was performed inside a semi-anechoic test chamber at Castle Hill.

Radiated emission testing below 30MHz was performed at an Open Area Test Site (OATS) at Yarramalong, where some ambient signals may exceed the limit. The possibility of missing an emission during testing is removed by performing pre-scans in a shielded enclosure prior to the final OATS measurements.

6.4 Measurement Uncertainties

The following uncertainties are for a 95% level of confidence, based on a coverage factor, k=2.

Test	Measurement Uncertainty
Mains port conducted emissions	±2.6dB
RF Frequency	±5 part in 10^{10}
RF power conducted	±1.3dB
RF power radiated	±4.7dB

6.5 Test Equipment

Testing – 02/11/2016 to 20/02/2017

ID	Brand/Model	Description	Last calibrated	Calibration due
798	CSW 5500	AC Source	Verified	
322	Chroma	AC Source	Verified	
337	EMCO 93110B	Antenna	12/12/2014	12/12/2017
336	EMCO 93146	Antenna	12/12/2014	12/12/2017
530	AH Systems SAS-571	Antenna	14/08/2014	14/08/2017
225	EM-6875	Antenna	02/09/2015	02/09/2017
811	Weinschel Corp BL8947	Attenuator	8/09/2015	8/09/2018
812	Weinschel Corp 10dB	Attenuator	8/09/2015	8/09/2018
799-1	Huber + Suhner Sucoflex 104	Cable	23/11/2015	23/11/2017
799-2	Huber + Suhner Sucoflex 104	Cable	23/11/2015	23/11/2017
799-3	Huber + Suhner Sucoflex 104	Cable	23/11/2015	23/11/2017
143	Huber + Suhner 223	Cable	21/10/2015	21/10/2017
144	Huber + Suhner FSJ-50	Cable	22/10/2015	22/10/2017
145	Huber + Suhner FSJ-50	Cable	22/10/2015	22/10/2017
146	Huber + Suhner RG214	Cable	21/10/2015	21/10/2017
680A	Huber + Suhner 104PEA	Cable	30/08/2015	30/08/2017
72	HP8574B	EMI Receiver	12/06/2015	12/06/2017
80	Com-power LI-200	LISN	07/07/2015	07/07/2017
924	Agilent U2021XA	Power Sensor	30/06/2014	30/06/2017
100	HP HP8447	Preamplifier	01/06/2015	01/06/2017
1241	Com-power PAM-118A	Preamplifier	04/09/2016	04/09/2017
1139	Agilent E4440A	Spectrum analyser	17/12/2015	17/12/2017
584	HP 8593E	Spectrum analyser	06/08/2015	06/08/2017
875	Rhode & Schwarz E0001A-FSP	Spectrum analyser	1/06/2016	1/06/2017
796	Com-Power LIT-930	Transient limiter	24/09/2015	27/07/2017
-	Teseq Compliance 5	Software	Verified	
-	HP85869PC Emissions	Software	Verified	
-	Agilent N1818A Power Analysis	Software	Verified	

All test equipment was checked and performance verified prior to testing.

Testing – 08/11/2017 and 22/11/1017

ID	Brand/Model	Description	Last calibrated	Calibration due
798	CSW 5500	AC Source	Verified	
322	Chroma	AC Source	Verified	
107	AH Systems SAS-571	Antenna	21/07/2016	21/07/2019
1132	AH Systems SAS-200/574	Antenna	23/07/2016	23/07/2019
811	Weinschel Corp BL8947	Attenuator	08/09/2015	08/09/2018
1232	Pasternack PE3C0666-100CM	Cable	19/05/2017	19/05/2019
1233	Pasternack PE3C0666-100CM	Cable	19/05/2017	19/05/2019
1244	Huber and Suhner SF106/2x11_N-651/8m 18GHz	Cable	18/05/2017	18/05/2019
1245	Huber and Suhner SF106/2x11_N-651/3m 18GHz	Cable	02/03/2017	02/03/2019
1249	Huber and Suhner SF106/2x11_N-651/1m 18GHz	Cable	02/03/2017	02/03/2019
680A	Huber + Suhner 104PEA	Cable	28/09/2017	28/09/2019
651	Rall RE-218A	Preamplifier	14/08/2017	14/08/2019
1242	Com-Power PAM-840A	Preamplifier	08/09/2017	08/09/2019
1139	Agilent E4440A	Spectrum analyser	17/12/2015	17/12/2017
1234	Keysight N9010A	Spectrum Analyser	21/10/2017	21.10/2019
1385	Rhode & Schwarz FSP40	Spectrum analyser	16/08/2017	16/08/2018
-	Teseq Compliance 5	Software	Verified	

All test equipment was checked and performance verified prior to testing.

7 FCC Part 15C, Section 15.203 – ANTENNA REQUIREMENT

The EUT complies with the requirement of this Section since the EUT antenna is integral and has no external antenna port.

8 FCC Part 15C, Section 15.205 – RESTRICTED BANDS OF OPERATION

The EUT complies with the requirements of this Section since it does not operate within the listed Restricted Bands of Operation. Out of band emissions falling within the Restricted Bands of Operation were found to be below limits specified in section 15.209.

9 FCC Part 15C, Section 15.207 - CONDUCTED LIMITS

Test Date:	2nd November 2016	Temperature:	23°C
Test Officer:	Joel Mulig	Humidity:	30%
Test Location:	Austest Laboratories (Castle Hill)		

9.1 EUT Test Operating Mode

a. Mains supply voltage – 115VAC 60Hz.
b. Mode 1 – Constant BLE transmission, ch0.
c. Mode 2 – Constant BLE transmission, ch19.
d. Mode 3 – Constant BLE transmission, ch39.

Preliminary measurements indicated no significant difference between transmission on different channels. Final measurement was performed using Mode 1.

9.2 Test Method

Measurements were made with the EUT internal batteries being charged using the supplied AC adaptor, BLE transmission on.

a) Measurements were performed in accordance with ANSI C63.10-2013, KDB 558074 D01 DTS Meas Guidance.
b) The measuring receiver BW settings were set to 9kHz.
c) The EUT was setup on a non-conductive platform, 0.8m above a conductive ground plane, with the rear of the EUT 0.8m away from a conductive vertical reference plane (in electrical contact with the ground plane), and 0.8m away from any other conductive surface.
d) EUT power was supplied through the EUT LISN. Power for supporting equipment (if any) was supplied through the supporting equipment LISN. Both LISNs were grounded to the ground plane and kept 0.8m away from the EUT test setup.
e) Power cable length between the EUT and the EUT LISN was maintained between 0.8m to 1m. Any excess power cable lengths were bundled together in the centre of the cable to form a bundle 30cm to 40cm long.
f) All interconnection cables were draped over the platform edge and kept them at least 40cm above the ground plane. Any excess cable lengths were bundled in the centre of the cable to form a bundle 30cm to 40cm long.
g) Conducted emission measurements were made on both Active and Neutral lines of the EUT at the respective LISN measurement points.

9.3 Sample Calculation Example

The final voltage levels were obtained from the measurement equipment software which automatically applied all the stored calibration factors. The calibration / correction factors were applied as follows:

$$V_c = V + L_{cbl} + L_{LISN} + L_{limiter}$$

Where:

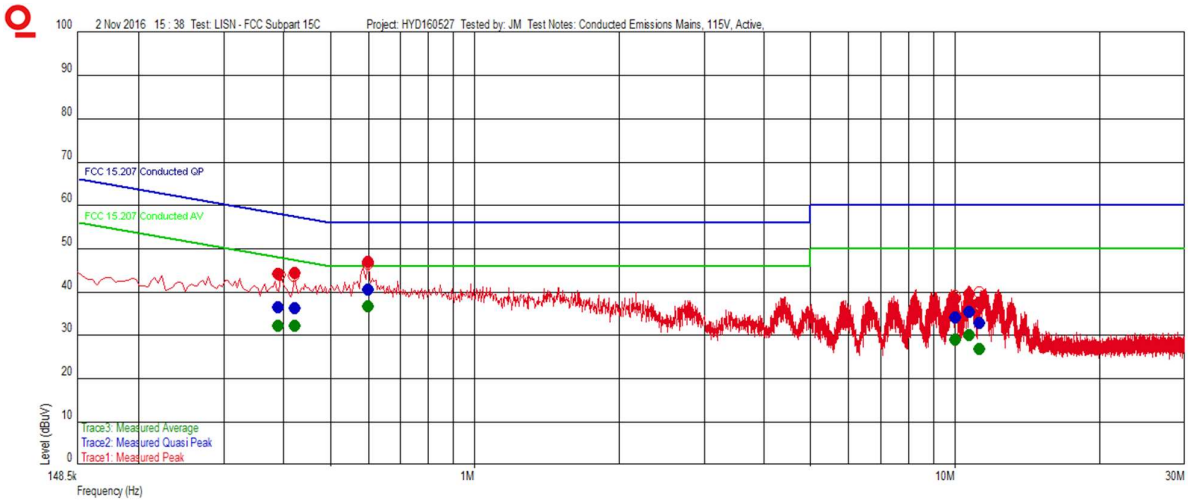
V_c	=	Corrected voltage level in dBµV for comparison to the limit.
V	=	EMI Receiver measured signal input voltage in dBµV.
L_{cbl}	=	Total cable insertion loss in dB.
L_{LISN}	=	Voltage division factor (insertion loss) of LISN in dB.
$L_{limiter}$	=	Insertion loss of voltage limiter, where applicable, in dB.

Frequency (MHz)	Receiver Level, V (dBµV)	L_{cbl} (dB)	L_{LISN} (dB)	$L_{limiter}$ (dB)	Corrected Level, V_c (dBµV)
1.0	40.0	0.1	0.1	N.A.	40.2

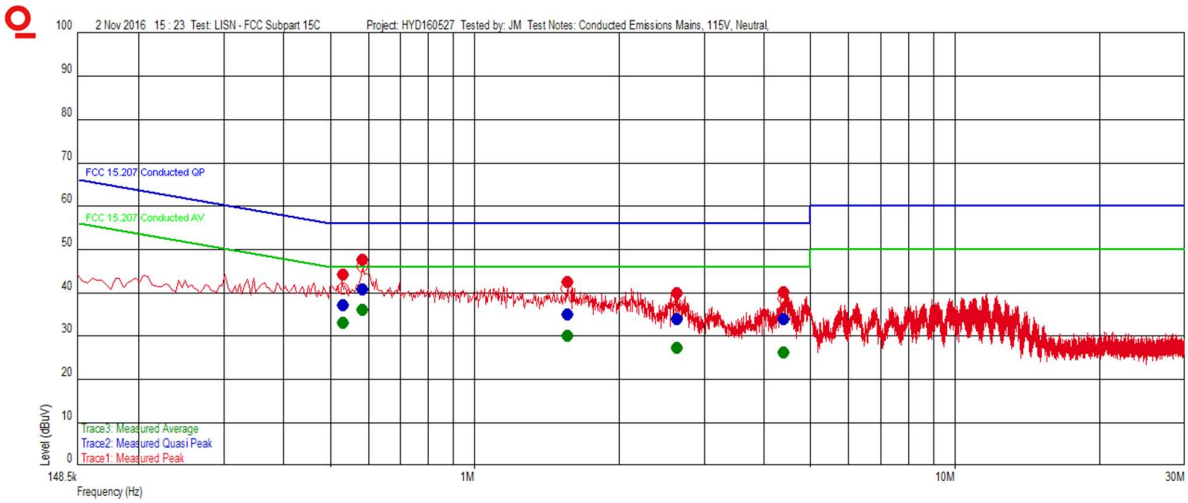
9.4 Test Results

The highest measured Quasi-peak level was 15.4dB below the 15.207 QP limit at 586kHz, measured at the Neutral terminal
The highest measured Average level was 9.5dB below the 15.207 Average limit at 600kHz, measured at the Active terminal.

Terminal	Frequency (kHz	AV Level (dBµV)	AV Limit (dBµV)	AV Pass Margin (dB) *
Active	600.	36.5	46.0	9.5
Neutral	586	35.9	46.0	10.1
Neutral	533	32.8	46.0	13.2
Active	423	32.1	47.4	15.3
Active	390	32.1	48.1	16.0
Neutral	1563	29.8	46.0	16.2



Conducted Emissions Plot (Active Line)



Conducted Emissions Plot (Neutral Line)

10 FCC Part 15C, Section 15.209 - RADIATED EMISSION LIMITS, GENERAL REQUIREMENTS

Test Date:	3rd, 7th and 8th November 2016 8th November 2017	Temperature:	22-24°C 20°C
Test Officer:	Richard Turner, Ron Leung	Humidity:	48 to 52% 50%
Test Location:	Austest Laboratories (Castle Hill, Yarramalong)		

10.1 EUT Operating Mode

a. Battery voltage – 4.35VDC.
b. Mode 1 – Constant BLE transmission, ch0.
c. Mode 2 – Constant BLE transmission, ch19.
d. Mode 3 – Constant BLE transmission, ch39.

Preliminary measurements indicated no significant difference in intentional emission levels when either the EUT was placed under charge with connection to a USB power adaptor, or without connection. Final testing was performed without connection to a USB adaptor, constant transmission on selected channels, powered by internal batteries.

Preliminary measurements were made to determine the orientation of the EUT that would generate the highest emission levels. Final measurement was made with the EUT laid flat on the test table, which was determined as worse case.

10.2 Test Method

a. Measurements were performed in accordance with ANSI C63.10-2013, KDB 558074 D01 DTS Meas Guidance.
b. The measuring receiver BW settings were set to:
   i. 9kHz (150kHz to 30MHz) EMI Receiver BW.
   ii. 120kHz (30MHz to 1GHz) EMI Receiver BW.
   iii. 1MHz (above 1GHz) RBW, 1MHz or more VBW, using a Spectrum Analyser for Peak measurements.
   iv. 1MHz (above 1GHz) RBW, 10Hz VBW with linear detection, using a Spectrum Analyser for Average measurements.
c. The EUT was setup on a non-conductive turntable. For measurement below 1GHz, 0.8m above the OATS conductive ground plane and at the indicated test distance away from the measuring antenna.
d. For measurements above 1GHz, 1.5m above the OATS conductive ground plane with RF absorber placed between the test table and measuring antenna..
e. To maximise emissions, the EUT was rotated through 360° and the measuring antenna height adjusted between 1m to 4m in the following antenna orientations:
   i. Loop antenna (150kHz to 30MHz) – Coaxial and coplanar orientations.

ii. Biconical and Log-Periodic antennas (30MHz to 1GHz) - Both vertical and horizontal polarizations.
iii. Horn antenna (above 1GHz) - Both vertical and horizontal polarizations.

f. The maximised emission was measured and the above repeated for all measurement frequencies.
g. Average level measurements were not made where the peak level did not exceed the average limit.
h. Linearity of the measuring system was checked, reducing gain when required.

10.3 Sample Calculation Example

The final radiated emission levels were obtained from the measurement equipment software which automatically applied all the stored calibration factors. The calibration / correction factors were applied as follows:

$$E = V + AF + L_{cbl} - G_{pre}$$

Where:

E	=	Radiated Electric Field Strength in dBµV/m at the specified distance.
V	=	EMI Receiver measured signal input voltage in dBµV.
AF	=	Antenna Factor of the measuring antenna in dB/m.
L_{cbl}	=	Total cable insertion loss in dB.
G_{pre}	=	Preamplifier gain in dB.

Frequency (MHz)	Receiver Level, V (dBµV)	AF (dB/m)	Lcbl (dB)	Gpre (dB)	Corrected Level, E (dBµV/m)
100.0	40.0	12.0	2.9	22.5	32.4

10.4 Test Results

The 6 highest EUT spurious emissions are tabulated below:

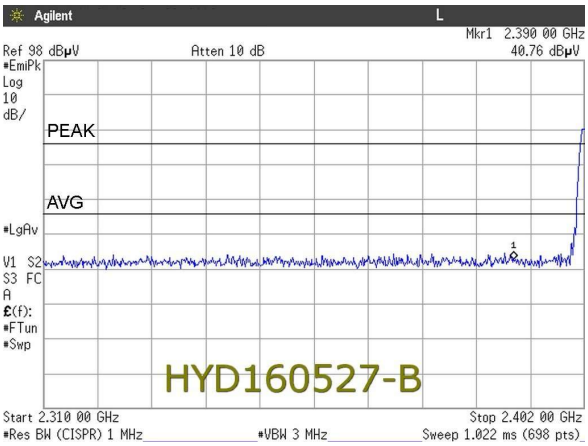
Frequency MHz	Channel	Antenna Pol.	Measured PK Level @ 1m dBµV/m	Extrapolated PK Level @ 3m dBµV/m	Limit @ 3m dBuV/m PK	Limit @ 3m dBuV/m AVG	Δ PK Limit (dB)
9918.8	39	Vertical	61.7	52.2	74.0	54.0	21.8
9919.8	39	Horizontal	61.1	51.6	74.0	54.0	22.4
9758.9	19	Vertical	58.8	49.3	74.0	54.0	24.7
9759.5	19	Horizontal	58.0	48.5	74.0	54.0	25.5
14638.3	19	Horizontal	57.3	47.8	74.0	54.0	26.2
14411.7	0	Vertical	57.2	47.7	74.0	54.0	26.3

10.4.1 Band edge measurements at 3m distance

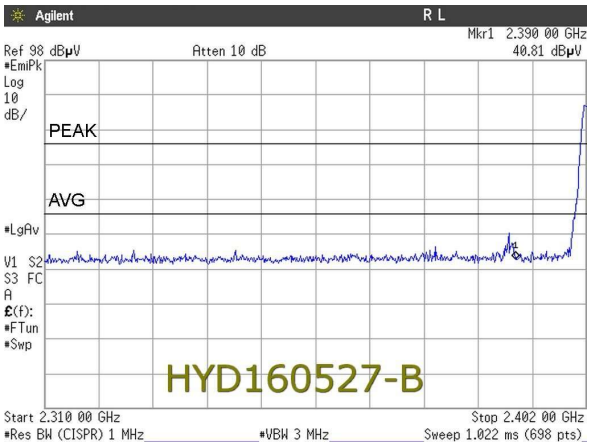
Restricted band 2310 to 2390MHz

All measured disturbances were greater than 10dB below the 15.209 average limit, and greater than 20dB below the 15.209 peak limit.

All modes assessed. Final measurement made using mode 1 – constant transmission, ch0.



Vertical

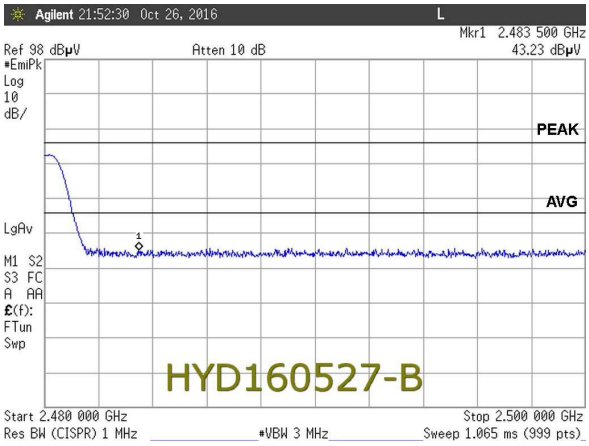


Horizontal

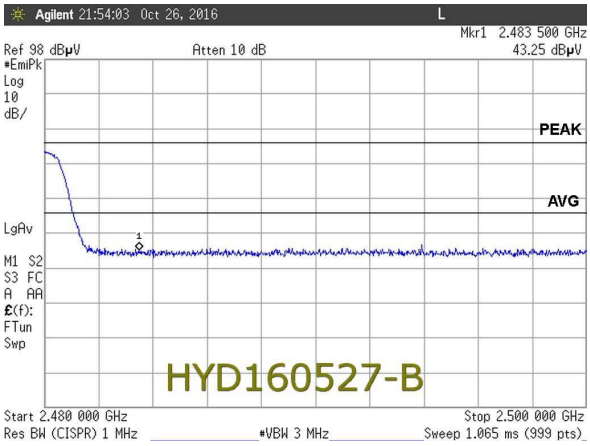
Restricted band 2483.5 to 2500MHz

All measured disturbances were greater than 10dB below the 15.209 average limit, and greater than 20dB below the 15.209 peak limit.

All modes assessed. Final measurement made using mode 3 – constant transmission, ch39.



Vertical -



Horizontal

10.4.2 Radiated Disturbances: 9kHz to 150kHz at 10m distance

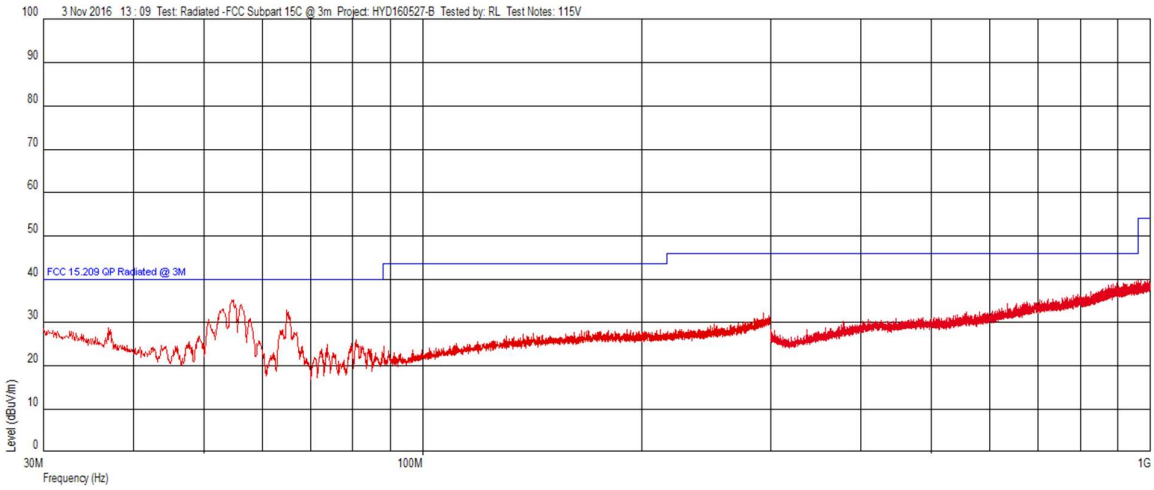
All intentional radiation was greater than 20dB below the limits specified in section 15.209. Emission levels were not affected by RF channel selection.

10.4.3 Radiated Disturbances: 150kHz to 30MHz at 3m distance

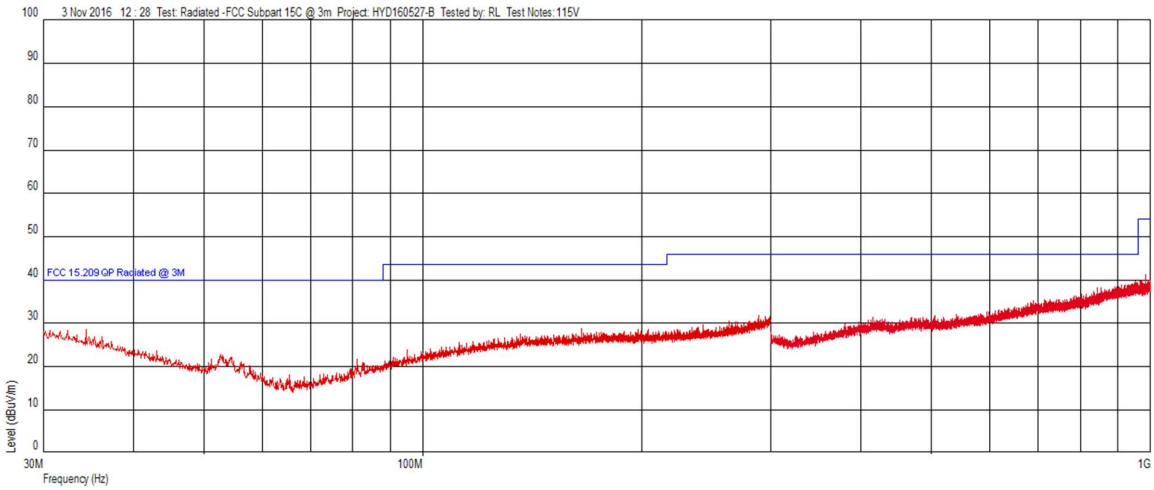
All intentional radiation was greater than 20dB below the limits specified in section 15.209. Emission levels were not affected by RF channel selection.

10.4.4 Radiated Disturbances: 30MHz to 1000MHz at 3m distance

All intentional radiation was greater than 10dB below the limits specified in section 15.209. Emission levels were not affected by RF channel selection. Final measurement made using mode 3, constant transmission ch39.



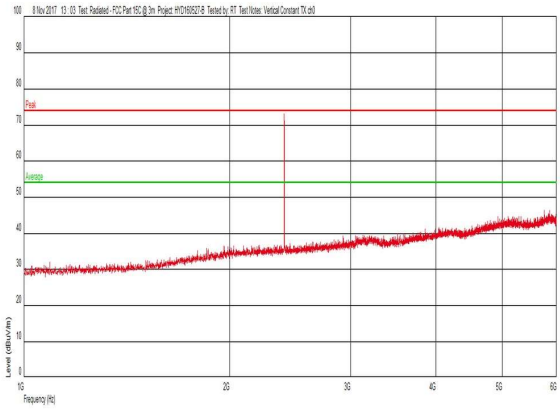
Radiated Emissions (30MHz to 1000MHz – Vertical)



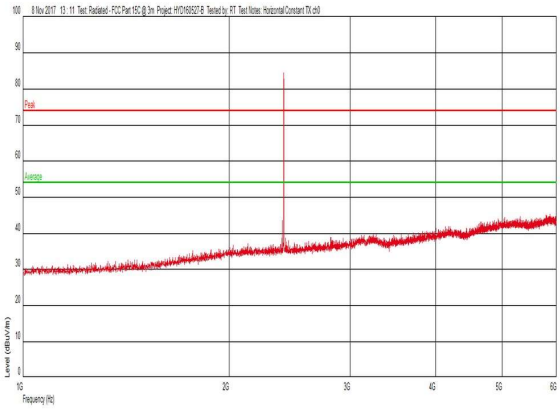
Radiated Emissions (30MHz to 1000MHz - Horizontal)

10.4.5 Radiated Disturbances: 1000MHz to 6000MHz at 3m distance

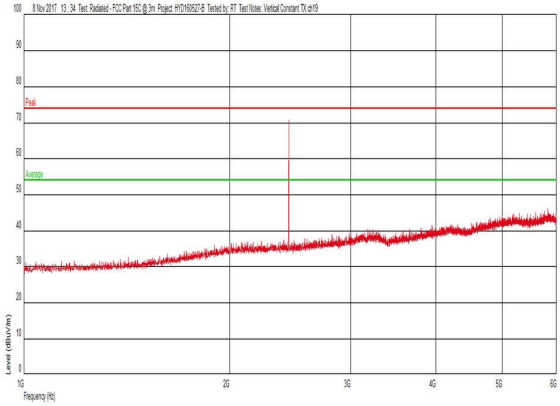
All intentional radiation was greater than 10dB below the limits specified in section 15.209.



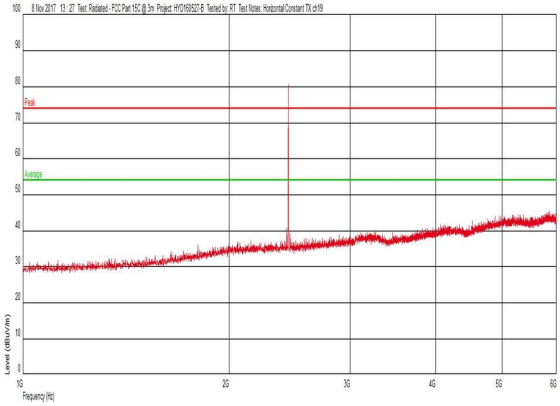
Ch0 – Vertical Polarisation



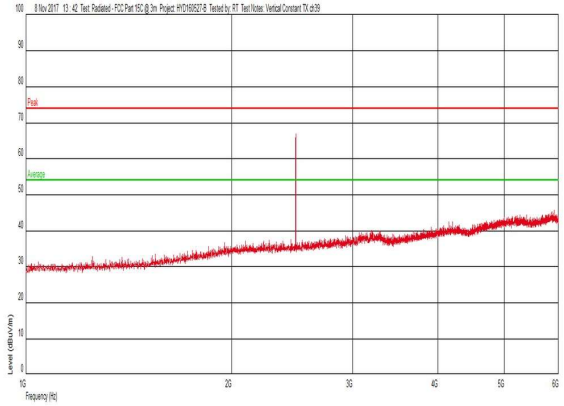
Ch0 – Horizontal Polarisation



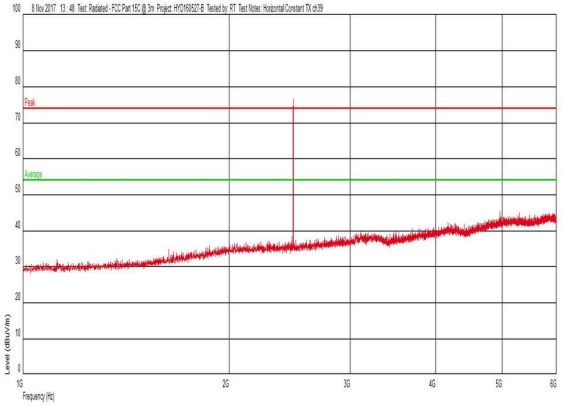
Ch19 – Vertical Polarisation



Ch19 – Horizontal Polarisation



Ch39 – Vertical Polarisation



Ch39 – Horizontal Polarisation

10.4.6 Radiated Disturbances: 6000MHz to 18000MHz at 1m distance

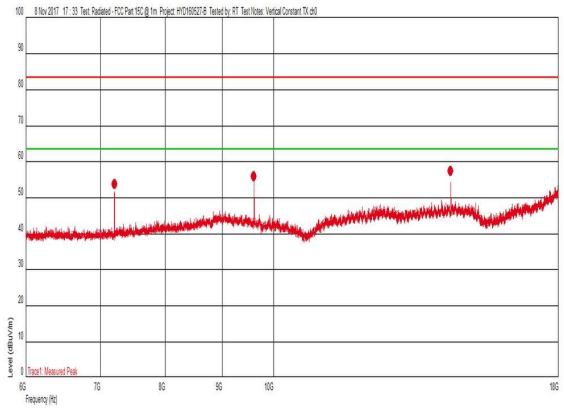
Measured field strength levels performed at a 1 metre distance were extrapolated to a 3 metre distance using the extrapolation factor of 20dB/decade as specified in section 15.31(f)(1).

All intentional radiation was greater than 10dB below the limits specified in section 15.209.

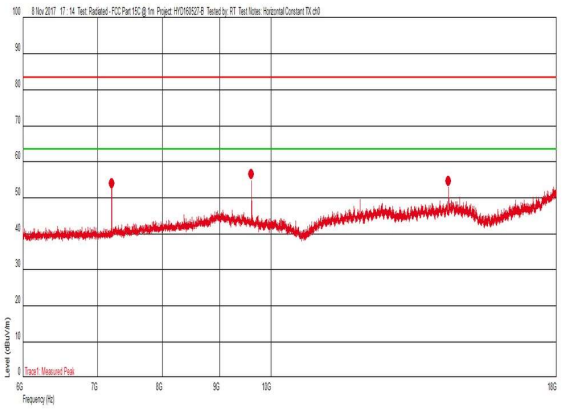
Highest measured peak emission level was 61.7dBuV/m at 9.919GHz, measured in vertical polarisation at a 1m distance. Transmission on Ch39 selected.
Extrapolated value, for 3m distance: 407µV/m.

As measured peak levels were below average limits, no average values were recorded.

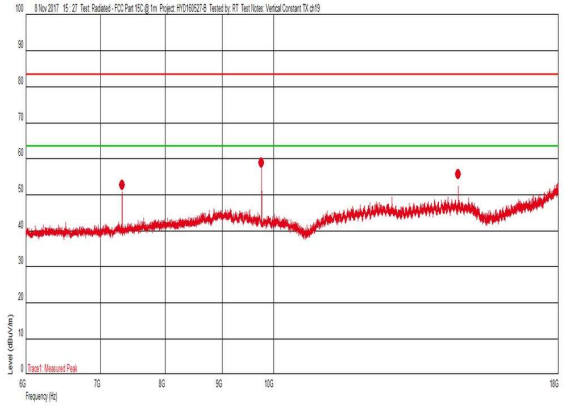
Following plots indicate limits calculated for a 1m distance



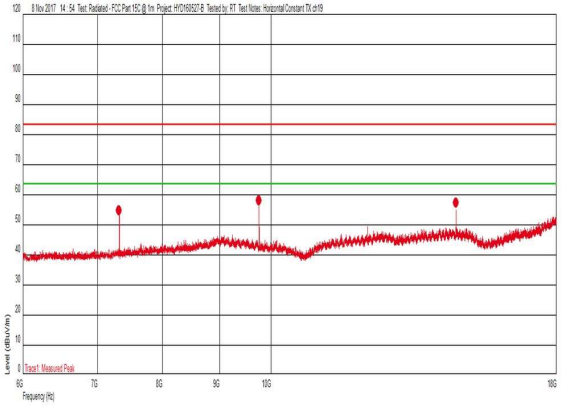
Ch0 – Vertical Polarisation



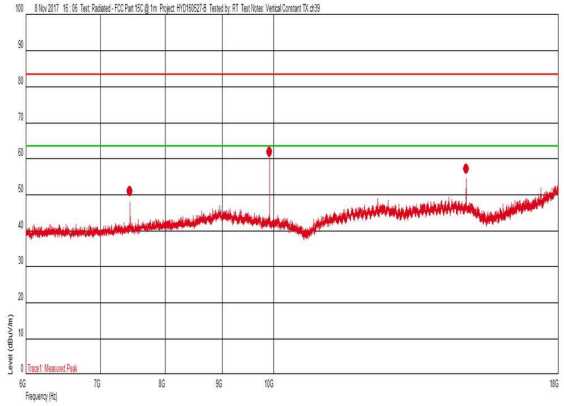
Ch0 – Horizontal Polarisation



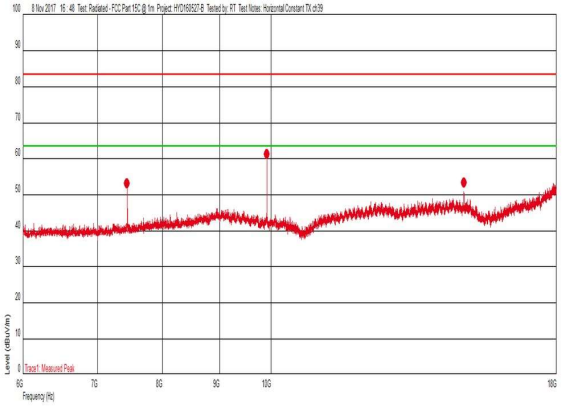
Ch19 – Vertical Polarisation



Ch19 – Horizontal Polarisation



Ch39 – Vertical Polarisation



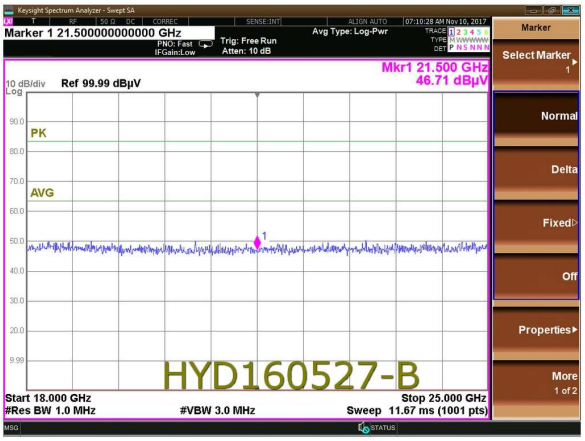
Ch39 – Horizontal Polarisation

10.4.7 Radiated Disturbances: 18000MHz to 25000MHz at 1m distance

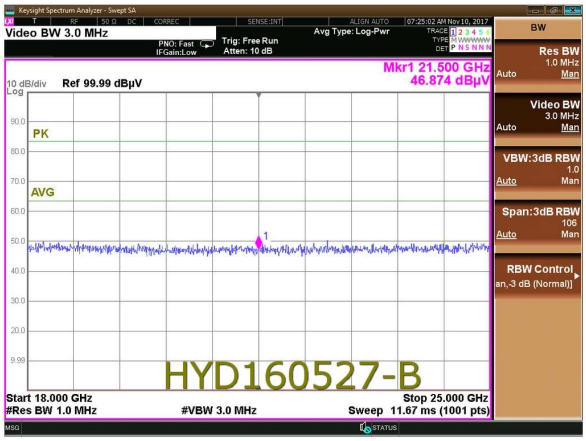
Measured field strength levels performed at a 1 metre distance were extrapolated to a 3 metre distance using the extrapolation factor of 20dB/decade as specified in section 15.31(f)(1).

All intentional radiation was greater than 10dB below the limits specified in section 15.209. Emission levels were not affected by RF channel selection. Final measurement made using mode 3, constant transmission ch39.

Following plots indicate limits calculated for a 1m distance



Vertical Polarisation



Horizontal Polarisation

11 FCC Part 15C, Section 15.247 – OPERATION WITHIN THE BANDS 902-928MHz, 2400-2483.5MHz, AND 5725-5850MHz

11.1 6dB Bandwidth - Section 15.247(a)(2)

Test Date:	8th February 2017	Temperature:	26°C
Test Officer:	Richard Turner	Humidity:	74%
Test Location:	Austest Laboratories (Yarra)		

11.1.1 EUT Operating Mode

a. Battery voltage – 4.35VDC.
b. Mode 1 – Constant BLE transmission, ch0.
c. Mode 2 – Constant BLE transmission, ch19.
d. Mode 3 – Constant BLE transmission, ch39.

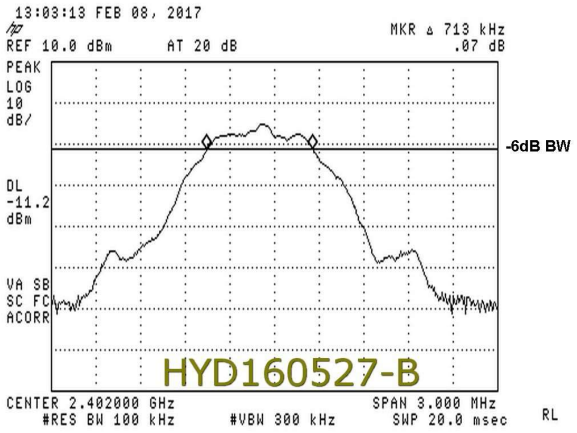
11.1.2 Test Method

Measurements were made using the supplied test box in which was placed the 5 EEG sensor array and PCB. The PCB was modified with chip antenna removed and external 50Ω coaxial RF output fitted. The test box also provided external battery and USB connection.
A DC power supply was connected to the battery terminals, output set to 4.2VDC.

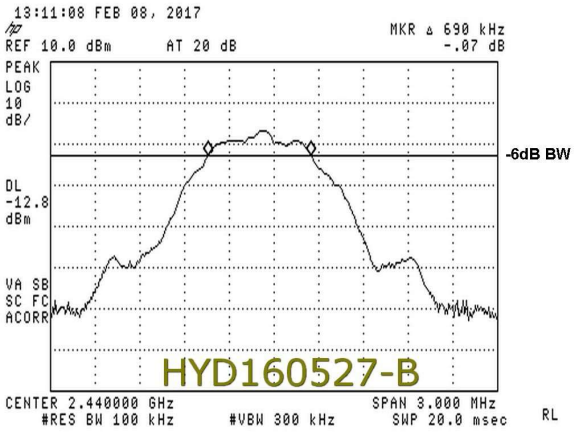
a. Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 D01 DTS Meas Guidance.
b. The EUT antenna port was connected to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
c. Spectrum analyser RBW 100kHz RBW, VBW 300kHz.
d. Peak level was marked and the -6dB (lower and upper) frequencies noted.
e. Measurements were repeated for the low, middle and high channels across all transmit modes.

11.1.3 Test Results

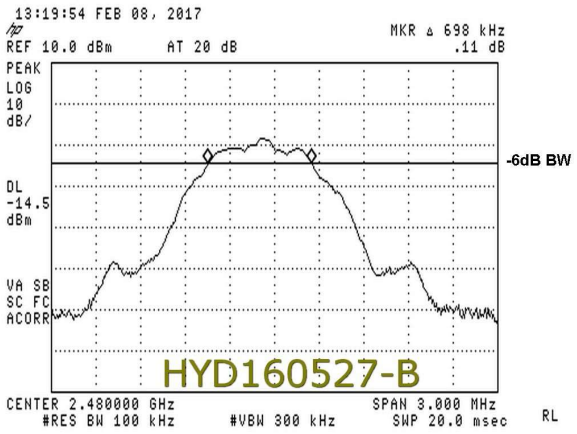
Channel	6dB Bandwidth (kHz)	6dB BW Limit (kHz)	Result
0	713	>500	COMPLIES
19	690	>500	COMPLIES
39	698	>500	COMPLIES



6dB Bandwidth – Ch0



6dB Bandwidth – Ch19



6dB Bandwidth – Ch39

11.2 Peak Conducted Output Power – Section 15.247(b)(3)

Test Date:	8th February 2017	Temperature:	26°C
Test Officer:	Richard Turner	Humidity:	74%
Test Location:	Austest Laboratories (Yarra)		

11.2.1 EUT Operating Mode

a. Battery voltage – 4.35VDC.
b. Mode 1 – Constant BLE transmission, ch0.
c. Mode 2 – Constant BLE transmission, ch19.
d. Mode 3 – Constant BLE transmission, ch39.

11.2.2 Test Method

Measurements were made using the supplied test box in which was placed the 5 EEG sensor array and PCB. The PCB was modified with chip antenna removed and external 50Ω coaxial RF output fitted. The test box also provided external battery and USB connection.
A DC power supply was connected to the battery terminals, output set to 4.2VDC.

a. Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 D01 DTS Meas Guidance.
b. The EUT antenna port was connected directly to a wideband peak power sensor via an attenuator. The U2021XA power sensor is USB powered and connected to a PC using the Agilent N1918A power analysis manager software.
c. The power sensor was set to measure peak power and VBW to low (5MHz).
d. Readings were corrected to account for attenuator loss.
e. The maximum reading was recorded.
f. Measurements were repeated for the low, middle and high channels and across all transmit modes.

11.2.3 Directional antenna gain

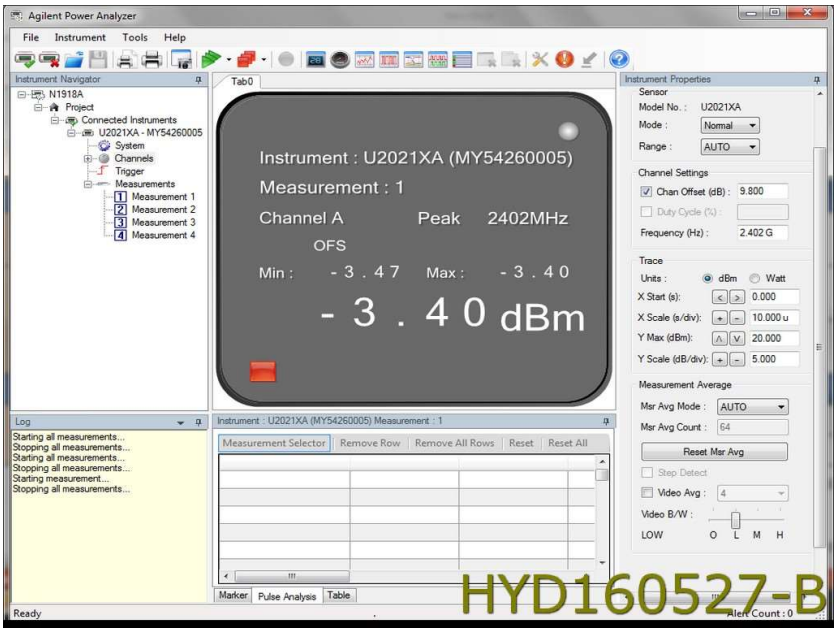
The maximum gain of the TDK multilayer chip antenna ANT016008LCS2442MA2 is as follows:

1.6dBi @ 2400MHz
2.5dBi @ 2442MHz
2.0dBi @ 2484MHz

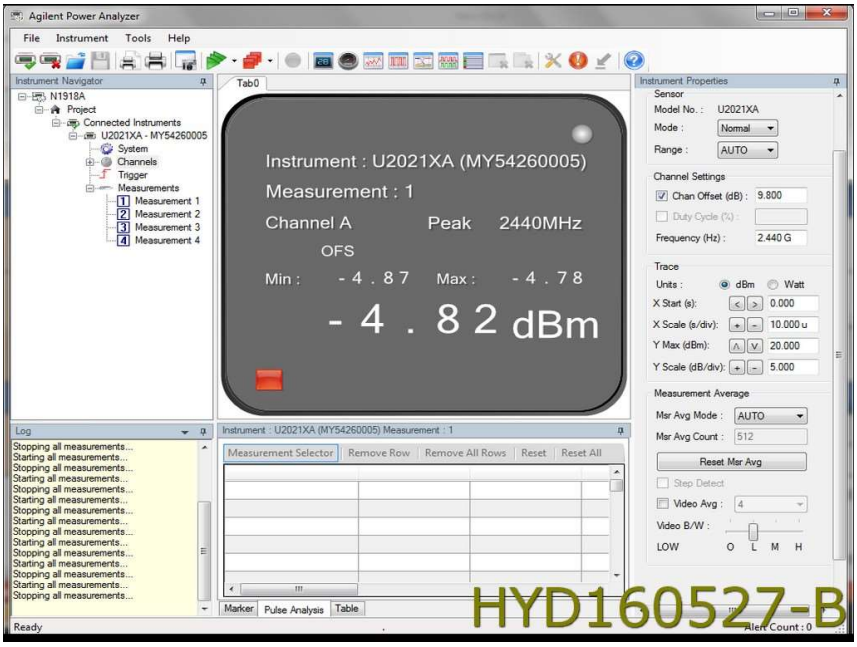
Section 15.247 (b) (4) indicates that the specified limit of 1W for conducted output power is based on the use of an antenna with a directional gain not exceeding 6dBi.

11.2.4 Test Results

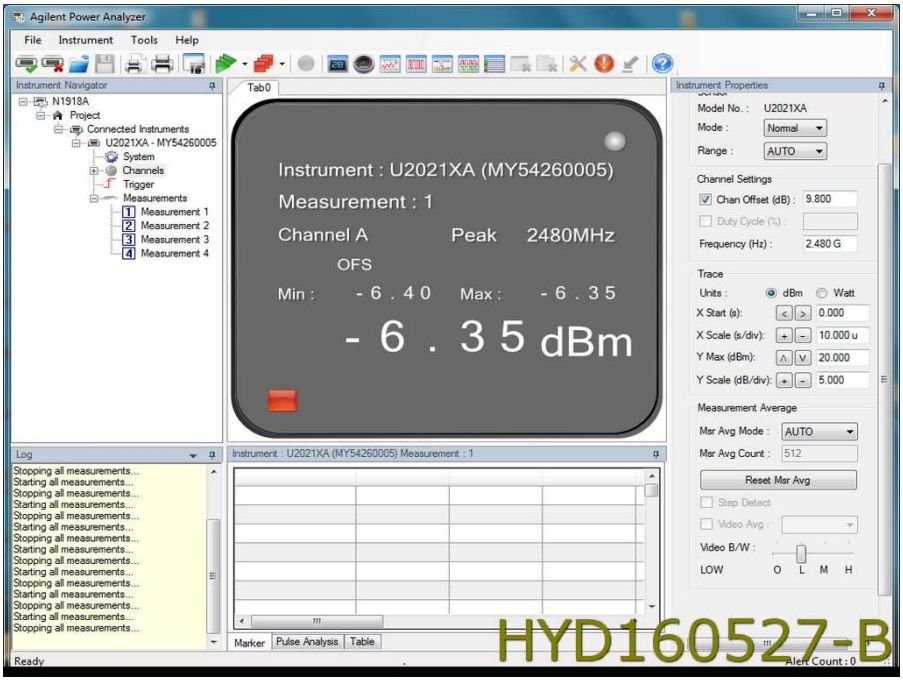
Channel	Output Power		Limit		Below Limit
	dBm	µW	dBm	W	dB
0	-3.4	457	30.0	1.0	33.4
19	-4.8	331	30.0	1.0	34.8
39	-6.4	229	30.0	1.0	36.4



Peak Output Conducted Power – Ch0



Peak Output Conducted Power – Ch19



Peak Output Conducted Power – Ch39

11.2.5 Transmit Power – Supply Voltage Variation

The EUT is powered from an internal 4.35V battery.

Section15.31 (e) requires transmitted power at the fundamental to be measured with the supply voltage varied between 85% and 115% of the nominal voltage range.

No change in transmit power at the fundamental was observed when the DC supply voltage was varied.

11.3 Out of band emissions – Section 15.247(d)

Test Date:	8th February 2017	Temperature:	26ºC
Test Officer:	Richard Turner	Humidity:	74%
Test Location:	Austest Laboratories (Yarra)		

11.3.1 EUT Operating Mode

a. Battery voltage – 4.35VDC.
b. Mode 1 – Constant BLE transmission, ch0.
c. Mode 2 – Constant BLE transmission, ch19.
d. Mode 3 – Constant BLE transmission, ch39.

11.3.2 Test Method

Measurements were made using the supplied test box in which was placed the 5 EEG sensor array and PCB. The PCB was modified with chip antenna removed and external 50Ω coaxial RF output fitted. The test box also provided external battery and USB connection.
A DC power supply was connected to the battery terminals, output set to 4.2VDC.

a. Measurements were performed in accordance with ANSI C63.10-2013, KDB 558074 D01 DTS Meas Guidance.
b. The EUT antenna port was connected directly to a spectrum analyser via a low loss RF cable, and attenuator.
c. Spectrum analyser RBW 100kHz, VBW to 100kHz or more. (At frequencies below 30MHz the RBW was set lower to reduce influence of the spectrum analysers zero point).
d. Measurements were made on the low. middle and high channels and highest in-band level recorded.
e. The frequency range was swept up to the 10th harmonic to locate the highest out of band emissions.
f. Any out of band emissions were measured to ensure they were are greater than 20dB below the recorded in band level.
g. Any emissions that fall within the restricted bands specified in section 15.205 shall also meet the radiated emission limits specified in section 15.209.
h. Measurements were repeated for the low, middle and high channel and across all transmit modes.

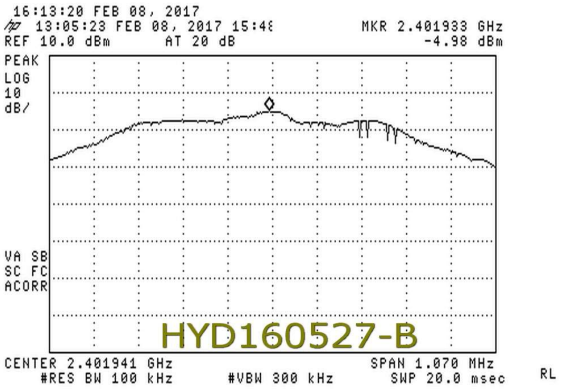
11.3.3 Test Results

Frequency range: 9kHz to 25000MHz.
Highest in-band level at 2401.9MHz, -5.0dBm (CH0).

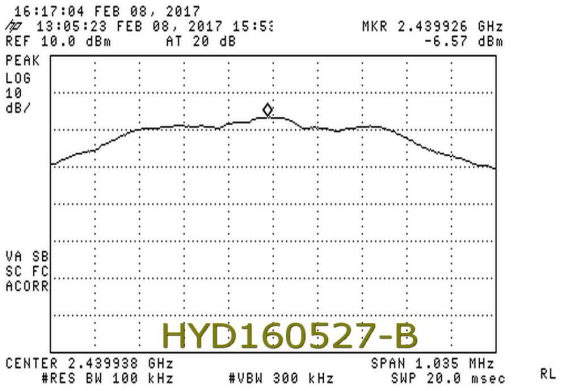
Measurement of peak conducted output power was used to determine compliance with section 15.247 (b) (3). Therefore the out of band emission limit is 20dB below the in-band level, -25.0dBm.

Highest measured out of band emission level was at 2389.1MHz which was 53.2dB below the highest in band level.

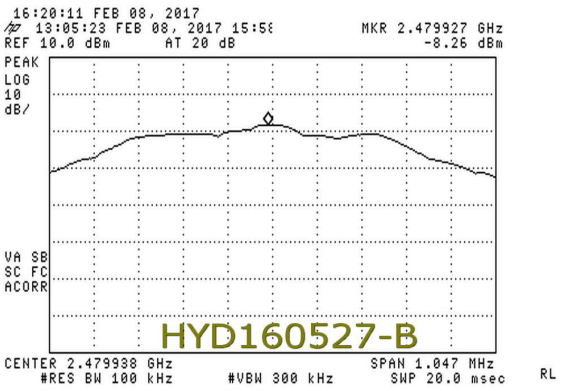
Frequency (MHz)	Channel	Peak Level (dBm)	Out of Band Limit (dBm)	Below Limit (dB)
2389.1	0	-58.2	-25.0	33.2
2492.8	39	-62.0	-25.0	37.0



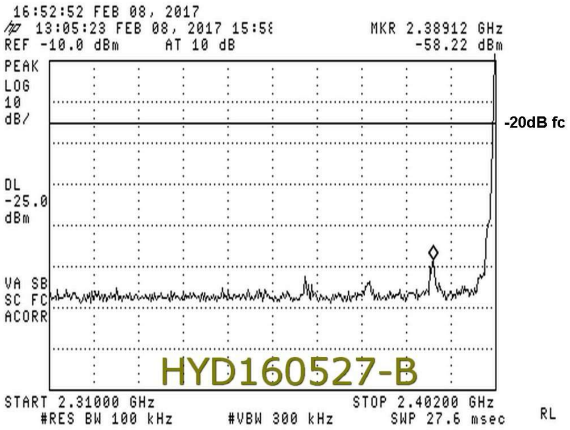
In-band – Ch0



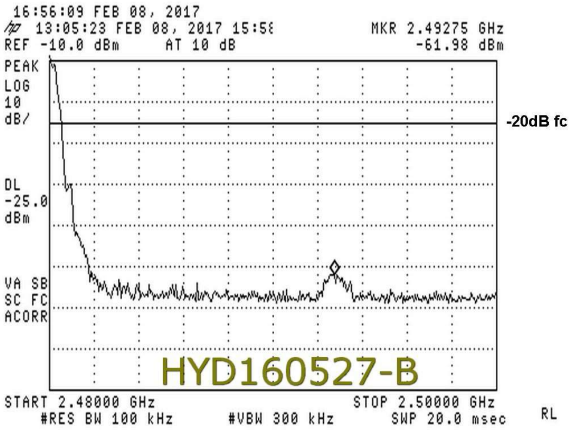
In-band – Ch19



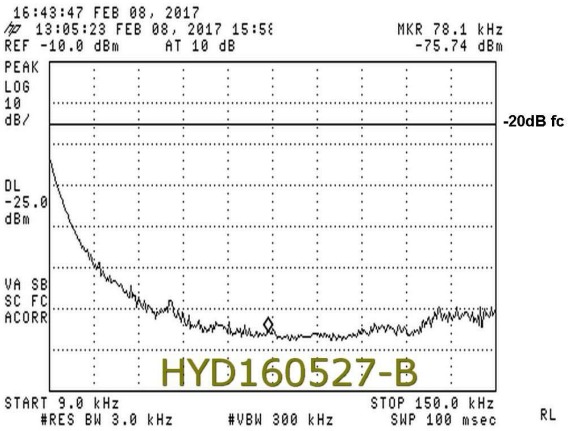
In-band – ch39



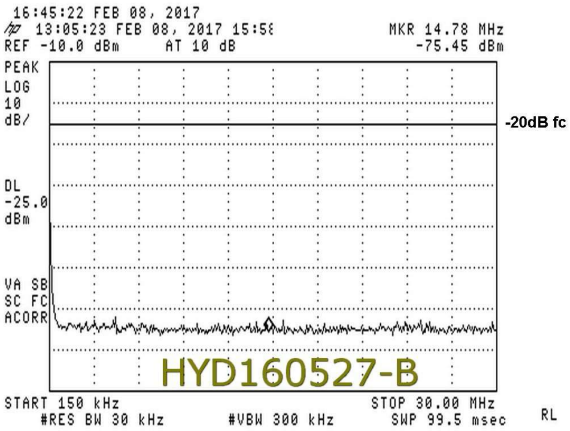
2310MHz to 2400MHz



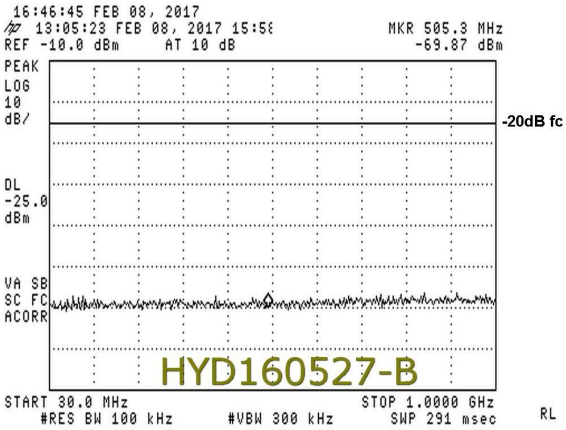
2483.5MHz to 2500MHz



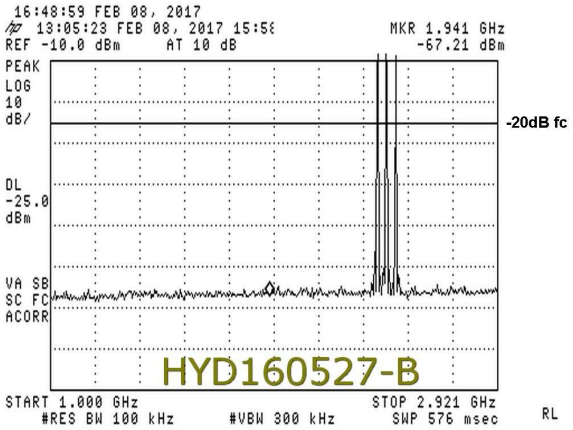
9kHz to 150kHz



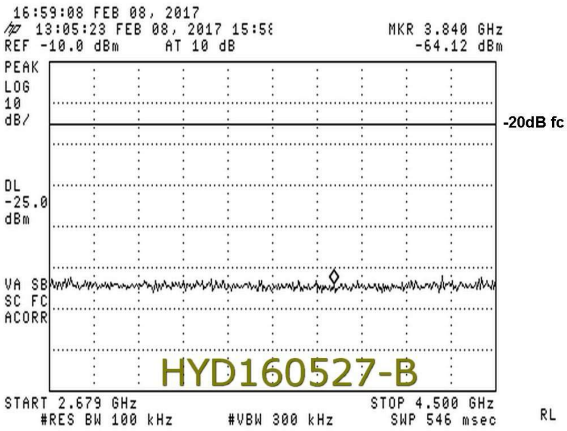
150kHz to 30MHz



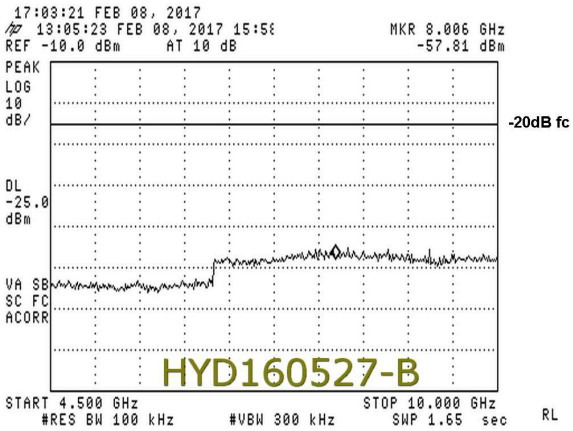
30MHz to 1000MHz



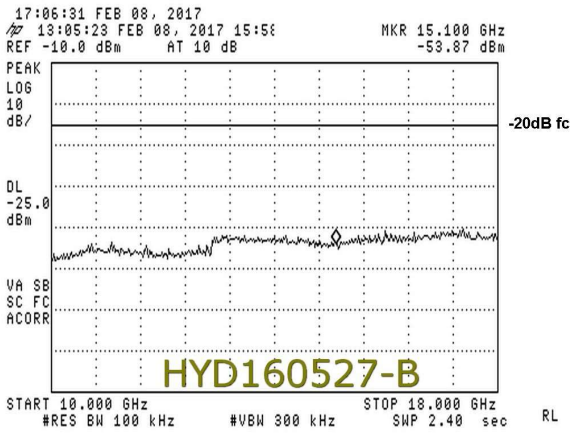
1000MHz to 2900MHz



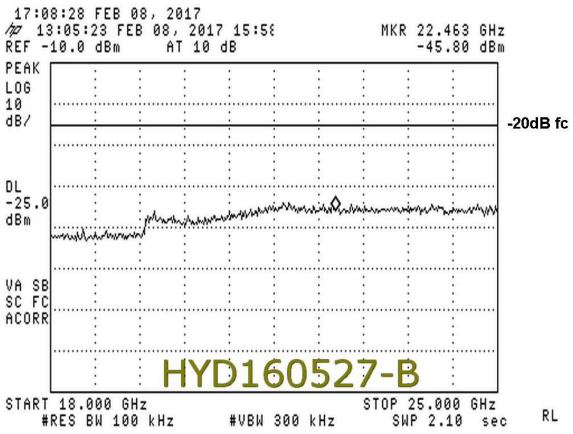
2600MHz to 4500MHz



4500MHz to 10000MHz



10000MHz to 18000MHz



18000MHz to 25000MHz

11.4 Peak Power Spectral Density – Section 15.247(e)

Test Date:	8th February 2017	Temperature:	26°C
Test Officer:	Richard Turner	Humidity:	74%
Test Location:	Austest Laboratories (Yarra)		

11.4.1 EUT Operating Mode

a. Battery voltage – 4.35VDC.
b. Mode 1 – Constant BLE transmission, ch0.
c. Mode 2 – Constant BLE transmission, ch19.
d. Mode 3 – Constant BLE transmission, ch39.

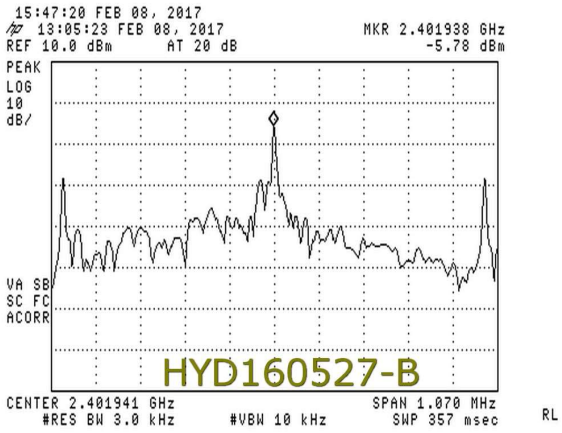
11.4.2 Test Method

Measurements were made using the supplied test box in which was placed the 5 EEG sensor array and PCB. The PCB was modified with chip antenna removed and external 50Ω coaxial RF output fitted. The test box also provided external battery and USB connection.
A DC power supply was connected to the battery terminals, output set to 4.2VDC.

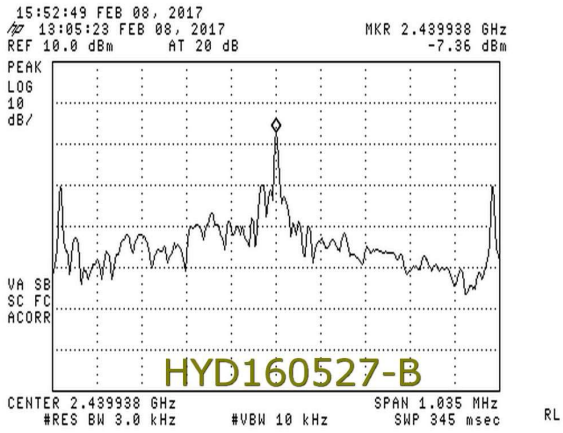
a. Measurements were performed in accordance with ANSI C63.10-2013 and KDB 558074 D01 DTS Meas Guidance.
b. The EUT antenna port was connected directly to a spectrum analyser via a low loss RF cable, and attenuator (as necessary).
c. Spectrum analyser RBW 3kHz, VBW 10kHz, span 1.5 x 6dB bandwidth.
d. The maximum reading was recorded.
e. Measurements were repeated for the low, middle and high channel and across all transmit modes.

11.4.3 Test Results

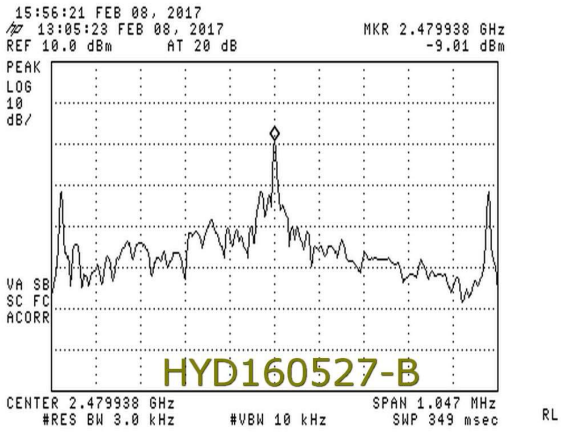
Channel	Frequency (MHz)	Power Density Level per 3kHz (dBm)	Power Density Limit (dBm)	Below Limit (dB)
0	2401.9	-5.8	8.0	13.8
19	2439.9	-7.4	8.0	15.4
39	2479.9	-9.0	8.0	17.0



Peak Power Spectral Density – Ch0



Peak Power Spectral Density – Ch19



Peak Power Spectral Density – Ch39

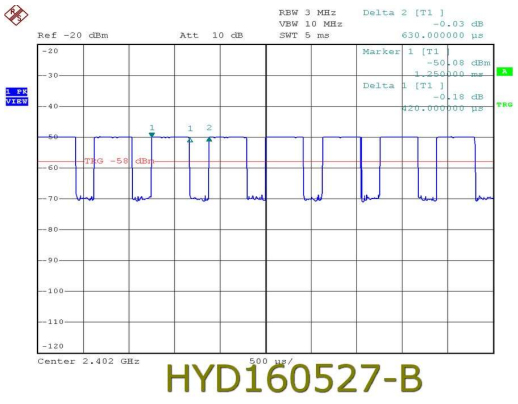
APPENDIX D – DUTY CYCLE

Test Date:	22nd November 2017	Temperature:	24ºC
Test Officer:	Richard Turner	Humidity:	53%
Test Location:	Austest Laboratories (Yarramalong)		

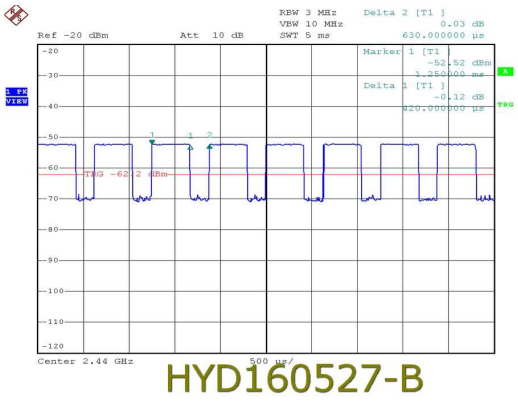
Measurements were performed in accordance with KDB 558074 section 6.0 using a spectrum analyser in zero-span mode.

TX On time: 420µs
TX On/Off time: 630µs

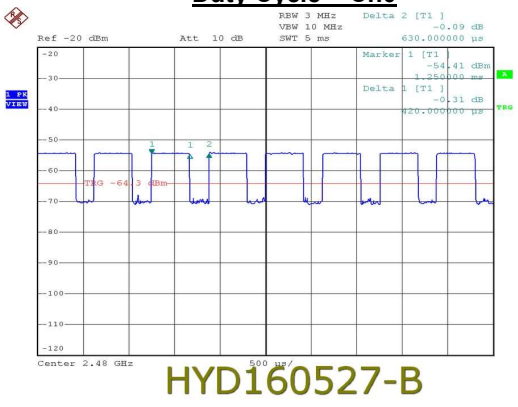
Duty Cycle calculated as 67%.



Duty Cycle – Ch0



Duty Cycle – Ch19



Duty Cycle – Ch39