

Listen Before Talk Evaluation

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FCC ID: XKYWAND1000 and XKYPTRD1000

General:

The Nevro Programmer Wand and Patient Remote are devices that interrogate the implantable device or the Trial Stimulator, respectively. They use listen before talk methods to select a channel to use for an interrogation session. The method used to select the channel is “Least Interfered Channel” (LIC). The system selects one of 8 frequencies separated by 300 kHz each from 402.45 MHz to 404.55 MHz. The 20dB bandwidth of the transmitter is 243 kHz.

Setup:

EUT: Programmer Wand
Agilent E8267C signal generator (multitone generator)
Agilent N5181A signal generator
EMCO 3143 biconilog antenna (for transmit)
HP 8593EM spectrum analyzer
Tuned dipole antenna

1) Threshold power level

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the 8 channels in the 402-405 MHz band. The output of the generator was connected to the biconilog antenna. The EUT and dipole antenna were placed on a table 2.5 m from the biconilog antenna.

The amplitude of the 7 carriers was measured with the dipole antenna located where the EUT was placed during the evaluation. With the setup described above, the -51dBm transmit level was set and the EIRP was calculated from the received amplitude measured on the spectrum analyzer. This received level was -98dBm. Adding 2.2dB (G) and subtracting 1.2dB (Cable Loss) gives -99dBm EIRP. This is less than -96dBm EIRP. (Per FCC 95.628: $10 * \log(243000) - 150 + G$). The G value is not used as the antenna for the EUT is integral with unknown gain and the measurement of the interfering signal EIRP accounts for the EUT antenna gain. The EUT was placed in search mode looking for an implanted device. At this amplitude, the EUT only initiated communications on the channel not generated by the signal generator.

Result: As the detected power level was less than -96dBm EIRP, the EUT complied with this requirement.

2) Monitoring System Bandwidth

The EUT has a bandpass filter in the receiver circuit used for LIC selection. The bandpass filter used during collection of data from the implantable device is wider than the filter used during LIC selection.

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the channels in the 402-405 MHz band. The Aglient N5181A signal generator was configured to transmit on the remaining channel (402.45 MHz) not being generated by the E8267C generator. The output of the generators were combined and connected to the biconilog antenna. The output level of the N5181A generator was adjusted higher than the output of E8267C generator. It was then verified that the EUT would not transmit at 402.45 MHz. The amplitude of the N5181A generator was lowered until the EUT begins to select 402.45 MHz for operation. The amplitude of the N5181A at this point was recorded as $P_a = -32\text{dBm}$. The frequency of the N5181A generator was changed to 402.3275 MHz (lower end of the 20dB bandwidth of the transmit signal) and the level of the generator adjusted until the EUT no longer transmits at 402.45 MHz). This level was recorded as $P_b = -24\text{dBm}$. The frequency of the N5181A generator was changed to 402.5725 MHz (upper end of the 20dB bandwidth of the transmit signal) and the level of the generator adjusted until the EUT no longer transmits at 402.45 MHz). This level was recorded as $P_c = -24\text{dBm}$.

Result: Since $P_b - P_a = 8\text{dB}$ and $P_c - P_a = 8\text{dB}$, the EUT complies with the 20dB monitoring bandwidth requirement.

3) Scan Cycle Time

Note: The EUT performs a clear channel assessment prior to initiating any transmission.

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the channels in the 402-405 MHz band. The Aglient N5181A signal generator was configured to transmit on the remaining channel (402.45 MHz) not being generated by the E8267C generator. The output of the generators were combined and connected to the biconilog antenna. The amplitude of the N5181A generator was adjusted to be 3dB higher than the amplitude of the E8267C generator. The EUT was set to initiate a transmission and in each case, selected a channel other then 402.45 MHz. The EUT was set to initiate a transmission and at the same time, the output of the N5181A generator was switched off. Each time, the EUT selected 402.45 MHz for the transmission in less than 1 second.

Result: Since the channel selection occurs in less than 5 seconds, the EUT complies with this requirement.

4) Minimum Channel Monitoring Period

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the channels in the 402-405 MHz band. The Aglient N5181A signal generator was configured to transmit of the remaining channel (402.45 MHz) not being generated by the E8267C generator. The output of the generators were combined and connected to the biconilog antenna. The amplitude of the N5181A generator was adjusted to be equal to the amplitude of the E8267C generator. The output of the E8267C generator was switched off and the EUT was set to initiate a transmission. The EUT did not transmit at 402.45 MHz. The output of the E8267C was switched back on and the amplitude increased by 3dB. The EUT was set to initiate a transmission. The EUT only transmitted at 402.45 MHz. The E8267C generator was configured with pulse modulation on all the carriers. The modulation was 0.1 ms pulse with a repetition frequency of 100 Hz corresponding to a silent period between pulses of 9.9 ms. The EUT was set to initiate a transmission 10 times. In each case, the EUT only transmitted at 402.45 MHz.

Result: Since the channel selection occurs only on 402.45 MHz, the EUT complies with this requirement.

5) Access based on lowest ambient level above PTh

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the channels in the 402-405 MHz band. The Aglient N5181A signal generator was configured to transmit of the remaining channel (402.45 MHz) not being generated by the E8267C generator. The output of the generators were combined and connected to the biconilog antenna. The amplitude of the E8267C generator was adjusted to produce a level of -89dBm EIRP at the EUT on 6 of the 7 channels. The amplitude at the 7th channel (403.95 MHz) was set to produce -96dBm EIRP (7 dB lower). The amplitude of the N5181A generator was adjusted to be -102dBm EIRP. The EUT was set to initiate a transmission and the EUT only transmitted at 402.45 MHz. The amplitude of the N5181A generator was adjusted to be -93dBm EIRP and the EUT was set to initiate a transmission. The EUT only selected 403.95 MHz for transmission.

Result: Since the EUT only selected 403.95 MHz for transmission, the EUT complied with this requirement.

6) Discontinuation of MICS session

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the channels in the 402-405 MHz band. The Agilent N5181A signal generator was configured to transmit the remaining channel (402.45 MHz) not being generated by the E8267C generator. The output of the generators were combined and connected to the biconilog antenna. The amplitude of the E8267C generator was adjusted to produce a level of -89dBm EIRP at the EUT on 6 of the 7 channels. The amplitude at the 7th channel (403.95 MHz) was set to produce -96dBm EIRP (7 dB lower). The amplitude of the N5181A generator was adjusted to be -93dBm EIRP. The EUT was set to initiate a transmission to communicate with the implantable pulse generator. The EUT transmitted at 403.95 MHz. The IPG was covered with foil to block the communications. The amplitude of the Agilent N5181A generator was adjusted to -102dBm EIRP. From the point in time when the IPG was blocked to the end of transmissions from the EUT was 3.7 seconds. After removing the covering, no transmissions were observed.

Result: Since the transmissions from the EUT stopped in less than 5 seconds and did not re-initiate, the EUT complied with this requirement.

Setup:

EUT: Patient Remote

Agilent E8267C signal generator (multitone generator)

Agilent N5181A signal generator

EMCO 3143 biconilog antenna (for transmit)

HP 8593EM spectrum analyzer

Tuned dipole antenna

1) Threshold power level

The Agilent E8267C signal generator was configured to produce 7 un-modulated carriers at 7 of the 8 channels in the 402-405 MHz band. The output of the generator was connected to the biconilog antenna. The EUT and dipole antenna were placed on a table 2.5 m from the biconilog antenna.

The amplitude of the 7 carriers was measured with the dipole antenna located where the EUT was placed during the evaluation. With the setup described above, the -51dBm transmit level was set and the EIRP was calculated from the received amplitude measured on the spectrum analyzer. This received level was -99dBm. Adding 2.2dB (G) and subtracting 1.2dB (Cable Loss) gives -100dBm EIRP. This is less than -96dBm EIRP. (Per FCC 95.628: $10 * \log(243000) - 150 + G$). The G value is not used as the antenna for the EUT is integral with unknown gain and the measurement of the interfering signal EIRP accounts for the EUT antenna gain. The EUT was placed in search mode looking for an implanted device. At this amplitude, the EUT only initiated communications on the channel not generated by the signal generator.

Result: As the detected power level was less than -96dBm EIRP, the EUT complied with this requirement.

The Programmer Wand and Patient Remote use identical schematics, antenna and software. There is a small difference in PCB layout and size, therefore only the Threshold Power Level test was repeated. The other tests on the patient remote were considered unnecessary.