Instruction for Preparing an Engineering Prototype

1 1 What is Engineering Prototype

Engineering prototype is used to enable testing of radio function. and to verify its design meet the normal efficient use of radio spectrum in order to avoid harmful interference.
Compared with normal prototype, special treatment is needed to be done on engineering sample to meet specific operation which can't be accessed with normal one, for example continuous emission at specified signal and power levels, selection of different transmission channels, rates, and modulation.

2 Why Engineering Prototype is needed

Generally, when a normal sample is in radio operation, it has several characteristics: intermittent, unstable (for example transmitted power may vary with the environment), variability (for equipment that support multiple modes of operation, its operating mode may automatically change frequently). With the mentioned issues, it'd be unfeasible to measure accurate RF parameters (transmit power and bandwidth for example) of the product. Therefore, special engineering prototype must be provided to achieve continuous and stable operation of the RF function. Operation status requirements of product varies from standard(s) applied, such status is accessible under engineering mode, in which parameters such as the RF power level, operating channel, data transmission rate and modulation method can be adjusted as desired to reflect parameters of general operations, thus make it possible to obtain true and accurate RF parameters of specific product in testing.

3 Requirements for Engineering Prototype

Requirements for Engineering Prototype varies from RF Function characteristics and applicable test standards applied. details as following:

3.1 TX Test

a) For RF product equipped with only single channel meanwhile single mode, only needs to ensure the engineering prototype working in a continuous transmitting state (applicable to 27MHz, 40MHz, 49MHz RC toy, or 315MHz, 433.92MHz Wireless doorbell application.).

b) For RF product supporting single channel but multiple modes, in addition to requirements in a), mode switching shall be satisfied so that the product could continuously transmit in each supported mode.

c) For RF products with multiple operation channels but single mode, generally it's required to select three channels (lowest, middle and highest) for testing. Engineering prototype must ensure that the products can be set at the mentioned three channels respectively, meanwhile keeping continuous transmission on each channel. Applicable wireless technology includes Bluetooth ® Low Energy, Zigbee, general proprietary protocol for 2.4G RC toys, etc.

d) For RF products supporting multi-channel and multiple modes, except meeting requirements in c), Engineering prototype is expected to continuously transmit in each mode of lowest, middle and highest channel. Typical wireless technology includes Wi-Fi (IEEE 802.11a/b/g/n/ac), Bluetooth Classic (utilizing modulation GFSK, Pi/4DQPSK, 8DPSK).

3.2 Receiving Radiated Spurious Emission test

Shall ensure engineering prototype continuously operating on receiving mode. For product with multi-mode and multi-channel, operation mode and operating channel are respectively expected to be able to switch.

3.3 Receiver Sensitivity, Receiver Blocking, Adjacent Channel Selectivity, etc.

These tests are carried out in normal communication state of transmitting and receiving, however determination of performance is involved, therefore, it's needed to provide a means to monitor performance of the product.
Here is a detailed explanation. For receiver blocking test of standard EN 300 328(generally applicable not limited to Bluetooth Technology, 2.4G Wi-Fi Technology), there're two approaches to evaluate its performance. One is quantifiable--detecting PER (Packet Error Rate), which could be achieved by using a communication tester for product employing standard protocol or achieved by using a means provided by manufacturer for a product employing a custom protocol. The other one for determination is to observe the working status of the product by comparing it before with during the test.

3.4 Shorten 5G WLAN DFS Test Lead Time

In Statistical Performance Check and Detection Bandwidth of DFS test, it's required to repeatedly load different types of radar wave signals to interfere with the product, then probability of detection is calculated based on the times of radar waves detected.
On normal sample, after detecting radar waves once, the operating channel shall be shifted. If it's shifted to a Non-DFS channel, the sample needs to be restarted then retested manually. Radar waveforms to be tested for this DFS test are up to 180 types for FCC requirements and 120 types for EU's EN standard. To perform DFS test on a normal sample directly, total lead time is about 20 hour-long for non-stop test.
While providing an engineering prototype remarkably help to shorten TAT and manual workload: once such sample detects radar wave, then inform testing engineer in a specific way which's been developed into the Engineering Prototype (for instance a flashing light indicator, displaying status through a platform, etc.), meanwhile keeping original operation. Therefore, radar wave interference can be continuously implemented without frequent restart and/or retest, which could greatly shorten testing time.

4 How to design an engineering prototype

There're various methods to nail an engineering prototype, no specific procedures or steps. General methods are summarized as follows, for TX test only.

4.1 For single-mode also single-channel product, take simple RC toys for example, if continuous transmit could be archived by setting the product at a specific function mode (e.g. forward, backward), additional engineering prototype is not needed unless the mentioned approach is not applicable. In addition, RC doorbell products for example adopting 315MHz, 433.92MHz frequency, engineering prototype could be made by connecting pins of RF chipset.

4.2 For single mode with multiple channels, highest, middle and lowest channel could be switched by pressing keys on Engineering Prototype or combination of product keys.

4.3 For multi-mode but single-channel, generally involve parameter changes such as modulation, bandwidth, thus special interface board which could connect to PC is needed to access mode switching control.

4.4 For multi-mode and multi-channel products, normally it could only be achieved through dedicated software after connecting prototype to computer via a dedicated interface board. RF chipsets used on such products are mostly developed after 2005 and chipset manufacturers could provide PC development tools of chipset, with which requirements of engineering prototype could be satisfied.

4.5 For smart products (such as mobile phones and tablets), it can be achieved through dedicated software loaded in the product or by entering the engineering code.

4.6 Commonly Used Interfaces

a) UART (USB to UART interface board available in the lab)
b) SPI (USB to SPI interface board available in the lab)
c) LAN
d) USB
e) SD Card

5 Sample requirements

1 pc of Conducted Engineering Prototype + 1 pc of Radiation Engineering Prototype

1. Conducted Sample: ANT connected to SMA Port（see below example）
2. Radiation Sample: whole antenna