



간편 사용자 매뉴얼

NB-IoT

young-min.park@viavisolutions.com

비아비솔루션스

AUG. 2017 Ver 1.0



NB-IoT 개요

NB-IoT 개요

Signal Structure

- UL and DL bandwidth of 180KHz
- Frequency error is specified to be ± 0.1 PPM
- OFDMA with 12 x 15KHz or 48 x 3.75KHz sub-carriers

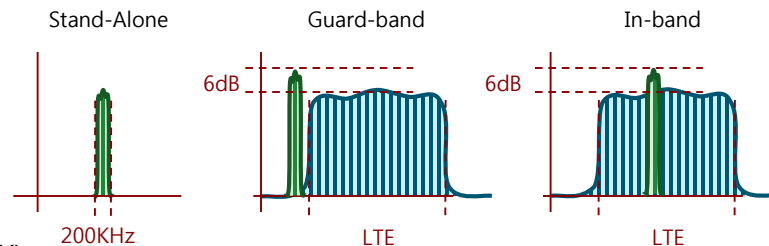
Uplink

- Narrowband Physical Uplink Shared Channel, **NPUSCH** (BPSK, QPSK)
- Narrowband Physical Random Access Channel, **NPRACH**
- Narrowband demodulation reference signal, **NDRS**

Downlink

- Narrowband Physical Downlink Shared Channel, **NPDSCH** (QPSK)
EVM $\geq 17.5\%$
- Narrowband Physical Broadcast Channel, **NPBCH** (QPSK)
- Narrowband Physical Downlink Control Channel, **NPDCCH** (QPSK)
- Narrowband reference signal, **NRS** (sub-frame 0, 4, and 9), SISO or MIMO 2x2 with TAE ≤ 65 ns
- Narrowband synchronization signal (**NPSS** and **NSSS**) including Cell ID

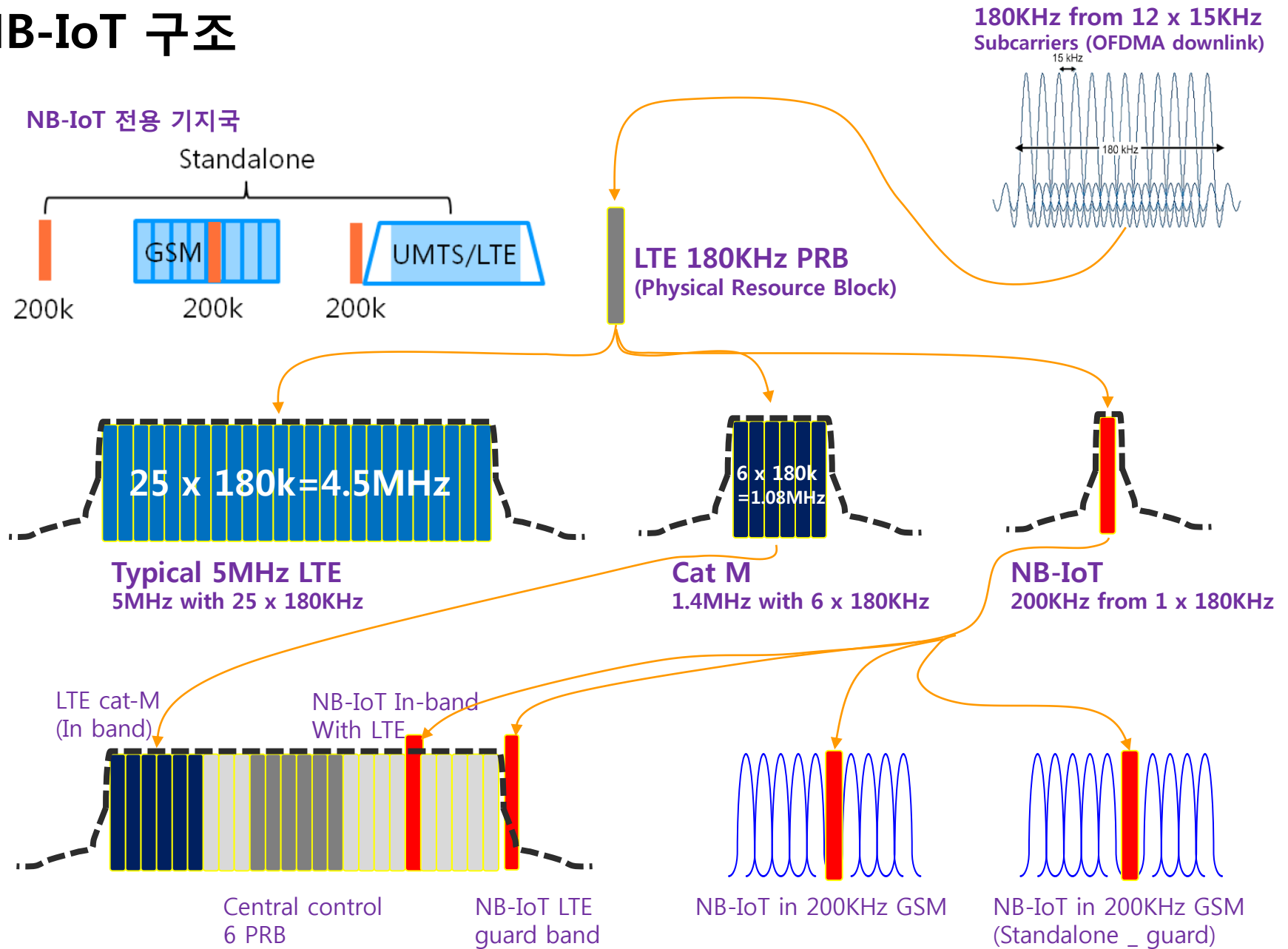
Modes of Operation



NB-IOT Operating Band	Uplink (UL) operating band BS receive UE transmit	Downlink (DL) operating band BS transmit UE receive	Duplex Mode
	$F_{UL_low} - F_{UL_high}$	$F_{DL_low} - F_{DL_high}$	
1	1920 MHz - 1980 MHz	2110 MHz - 2170 MHz	HD-FDD
3	1710 MHz - 1785 MHz	1805 MHz - 1880 MHz	HD-FDD
5	824 MHz - 849 MHz	869 MHz - 894MHz	HD-FDD
8	880 MHz - 915 MHz	925 MHz - 960 MHz	HD-FDD
12	699 MHz - 716 MHz	729 MHz - 746 MHz	HD-FDD
13	777 MHz - 787 MHz	746 MHz - 756 MHz	HD-FDD
17	704 MHz - 716 MHz	734 MHz - 746 MHz	HD-FDD
19	830 MHz - 845 MHz	875 MHz - 890 MHz	HD-FDD
20	832 MHz - 862 MHz	791 MHz - 821 MHz	HD-FDD
26	814 MHz - 849 MHz	859 MHz - 894 MHz	HD-FDD
28	703 MHz - 748 MHz	758 MHz - 803 MHz	HD-FDD

Source: 3GPP 36.802, 36.104, 36.211

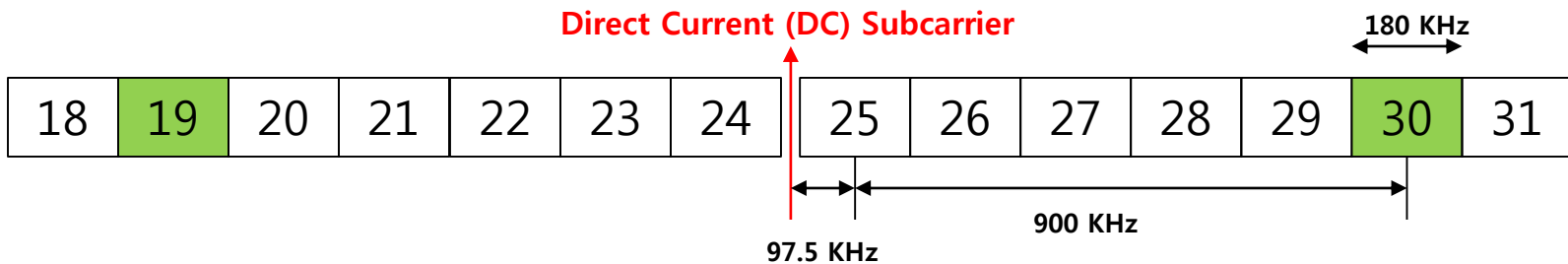
NB-IoT 구조



운용 모드 및 주파수

• In-Band 앵커 캐리어의 배치 알고리즘

- BW 10MHz (50 PRBs) 일 때

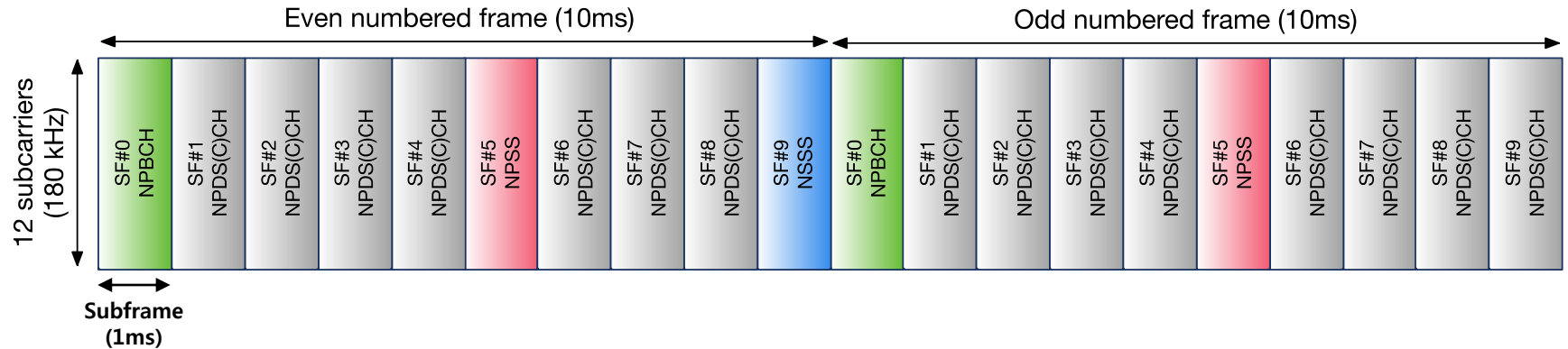


- LTE BW에 따른 NB-IoT 할당 표

LTE Bandwidth	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
NB-IoT 동기화를 위한 LTE PRB 인덱스	2, 12	2, 7, 17, 22	4, 9, 14, 19, 30, 35, 40, 45	2, 7, 12, 17, 22, 27, 32, 42, 47, 52, 57, 62, 67, 72	4, 9, 14, 19, 24, 29, 34, 39, 44, 55, 60, 65, 70, 75, 80, 85, 90, 95

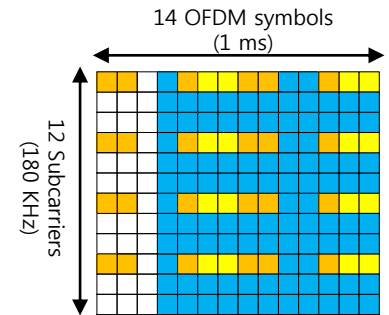
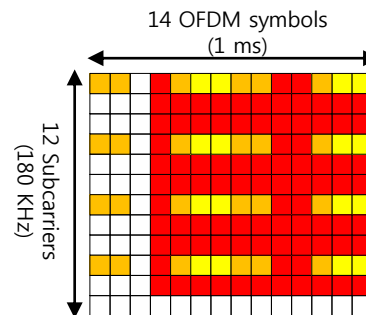
물리채널 (다운링크)

- 다운링크 물리채널 시간영역 다중화



NRS
LTE-RS

- **NPSS** (Narrowband Primary Synchronization Signal):
 - 동기 신호
- **NSSS** (Narrowband Secondary Synchronization Signal):
 - 물리 셀 아이 디(PCI, Physical Cell Identity)



NB-IoT 표준 기술 규격 (3GPP TS 36.141 v14.2.0)

- Maximum Output Power:
 - Standalone NB-IoT: **± 3dB** 이내
 - In-Band NB-IoT: **± 3.5dB** 이내
- 점유대역폭: **200KHz** 이내
- NB-IoT RB power dynamic range (In-band or Guard band): **6 dB** 이상
- 주파수 허용 편차: **±0.05 ppm**이내
- NPDSCH EVM(QPSK): **17.5%** 이하
- ACLR:
 - Standalone NB-IoT: **40 dB** (ACLR1) / **50 dB** (ACLR2)

Note 1

$$\text{Max}(6.5\text{dBm} - 60 \cdot \left(\frac{f_{\text{offset}}}{\text{MHz}} - 0.015\right) \text{dB} + X\text{dB}, -12.5\text{dBm})$$

Note 2

$$\text{Max}(3.5\text{dBm} - 160 \cdot \left(\frac{f_{\text{offset}}}{\text{MHz}} - 0.065\right) \text{dB} + X\text{dB}, -12.5\text{dBm})$$

Note 3

$$-12.5\text{dBm} - 15 \cdot \left(\frac{f_{\text{-offset}}}{\text{MHz}} - 0.215\right) \text{dB}$$

Channel bandwidth of NB-IoT: BW_{Channel} [kHz]	서비스 중심 주파수에서의 오프셋	측정 필터 대역폭	ACLR limit
200	300 kHz	Square (180 kHz)	40 dB
	500 kHz	Square (180 kHz)	50 dB

- Time alignment error (NRS): **65 ns** 이내
- Operating band unwanted emission:

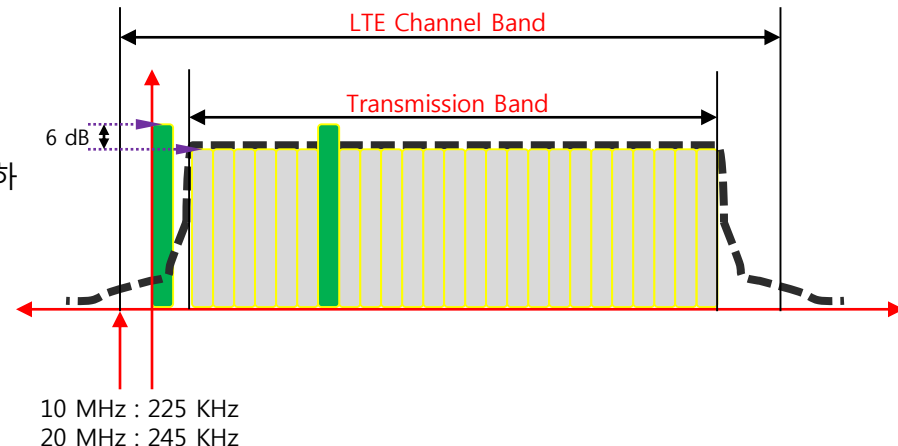
Frequency offset of measurement filter -3dB point, Δf	Frequency offset of measurement filter centre frequency, f_{offset}	Minimum requirement	Measurement bandwidth
$0 \text{ MHz} \leq \Delta f < 0.05 \text{ MHz}$	$0.015 \text{ MHz} \leq f_{\text{offset}} < 0.065 \text{ MHz}$	Note 1	30 kHz
$0.05 \text{ MHz} \leq \Delta f < 0.15 \text{ MHz}$	$0.065 \text{ MHz} \leq f_{\text{offset}} < 0.165 \text{ MHz}$	Note 2	30 kHz
$0.15 \text{ MHz} \leq \Delta f < 0.2 \text{ MHz}$	$0.165 \text{ MHz} \leq f_{\text{offset}} < 0.215 \text{ MHz}$	-12.5 dBm	30 kHz
$0.2 \text{ MHz} \leq \Delta f < 1 \text{ MHz}$	$0.215 \text{ MHz} \leq f_{\text{offset}} < 1.015 \text{ MHz}$	Note 3	30 kHz
규격 없음 (Note 6)	$1.015 \text{ MHz} \leq f_{\text{offset}} < 1.5 \text{ MHz}$	-24.5 dBm	30 kHz
$1 \text{ MHz} \leq \Delta f \leq \min(\Delta f_{\text{max}}, 10 \text{ MHz})$	$1.5 \text{ MHz} \leq f_{\text{offset}} < \min(f_{\text{offset}_{\text{max}}}, 10.5 \text{ MHz})$	-11.5 dBm	1 MHz
$10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$	$10.5 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$	-15 dBm	1 MHz

NB-IoT 기술 규격 (국립전파연구원 지침)

800MHz 대역과 1.8GHz 대역에 이동통신용 NB-IoT 기술 기준 안 신설 (안 제4조6항_국립전파연구원)
 본 문서는 전용 기지국에 대한 규격이며 인수시험은 In-Band, Guard-Band는 LTE 기술기준에 따라 검사를
 하고 **Stand alone(전용기지국)에 본 규격을 적용** 합니다.

- SKT, LGU+ : 800MHz 사용
- KT 1800MHz 사용

- 인접대역 간섭으로 인한 경계 대역 설정
 - LTE 지정 주파수 경계부터 **10 MHz: 225 KHz, 20 MHz:245 KHz** 이격
- 안테나 공급전력: **(점유 주파수 대역폭 X 0.4/KHz) W** 이하
- 주파수 허용 편차: $\pm(\text{지정 주파수} \times 5 \times 10^{-8})$ 이내
- 점유 주파수 대역폭: **200 KHz** 이하
- 인접채널 누설전력:
 - CF ± 300 KHz (**40dBc**)
 - CF ± 500 KHz (**50dBc**)
- 대역외 발사
 - $\pm 0.215 \sim 0.265$ MHz @ 30 KHz: -14dBm 이하
 - $\pm 0.265 \sim 0.365$ MHz @ 30 KHz: -14dBm 이하
 - $\pm 0.365 \sim 0.415$ MHz @ 30 KHz: -14dBm 이하
 - $\pm 0.415 \sim 1.215$ MHz @ 30 KHz: $[-14-15 \times (\Delta f - 0.415)]$ dBm 이하
 - $\pm 1.215 \sim 1.7$ MHz @ 30 KHz: -26dBm 이하
 - $\pm 1.7 \sim 10.7$ MHz @ 1 MHz: -13dBm 이하
- 스퓨리어스 발사
 - 30 MHz ~ 1GHz @ 100 KHz: -13 dBm 이하
 - 1 GHz ~ 12.75 GHz @ 1 MHz: -13 dBm 이하
 - 879 MHz ~ 849 MHz @ 100 KHz: -76 dBm 이하
 - 898 MHz ~ 900 MHz @ 100 KHz: -32 dBm 이하

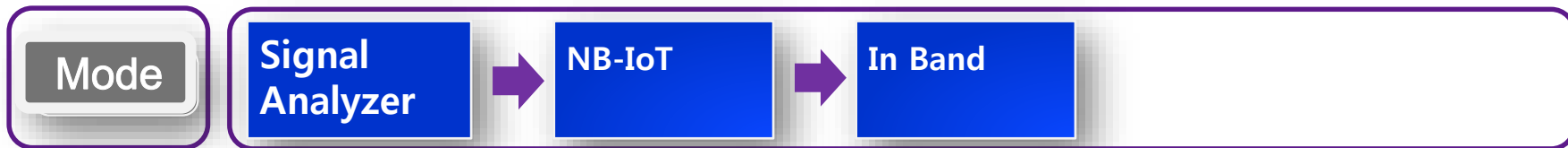


NB-IoT 측정

In Band

NB-IoT (In-Band)

측정 순서



Measure Setup 4

Bandwidth
10MHz

NB-IoT (In Band)가 있는 LTE Bandwidth를 설정

NB-IoT PRB Index
19

아래 NB-IoT 할당 표를 참조하여 PRB 번호를 입력 합니다. 아래 표는 3GPP 표준에 정의하고 있는 NB-IoT 출력의 앵커 캐리어 위치 입니다.

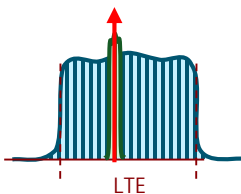
LTE system bandwidth	3 MHz	5 MHz	10 MHz	15 MHz	20 MHz
LTE PRB indices for NB-IoT synchronization	2, 12	2, 7, 17, 22	4, 9, 14, 19, 30, 35, 40, 45	2, 7, 12, 17, 22, 27, 32, 42, 47, 52, 57, 62, 67, 72	4, 9, 14, 19, 24, 29, 34, 39, 44, 55, 60, 65, 70, 75, 80, 85, 90, 95

Subframe No
0

측정 할 subframe 설정. 이 메뉴는 *Measure Type* 이 subframe 일 때만 활성화 됩니다.

Measure Type
Frame Subframe

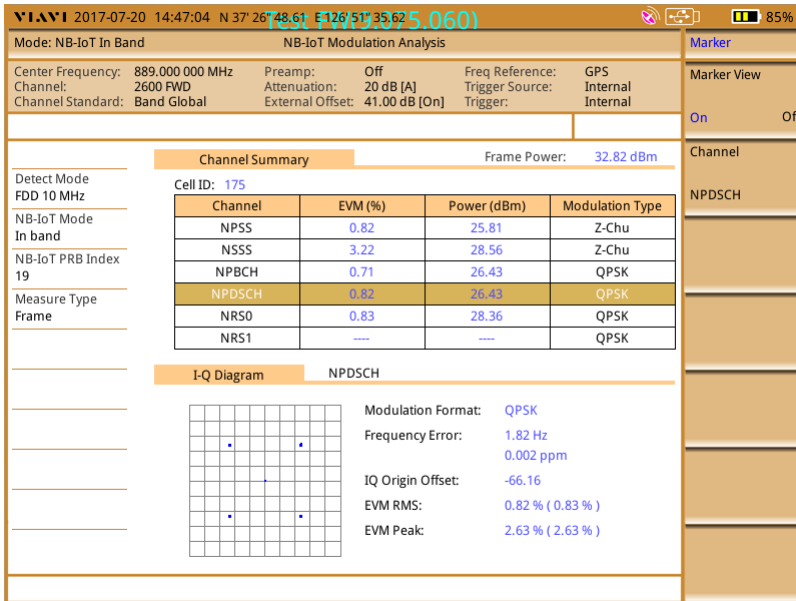
측정 결과를 Subframe 또는 Frame으로 설정할 수 있습니다.



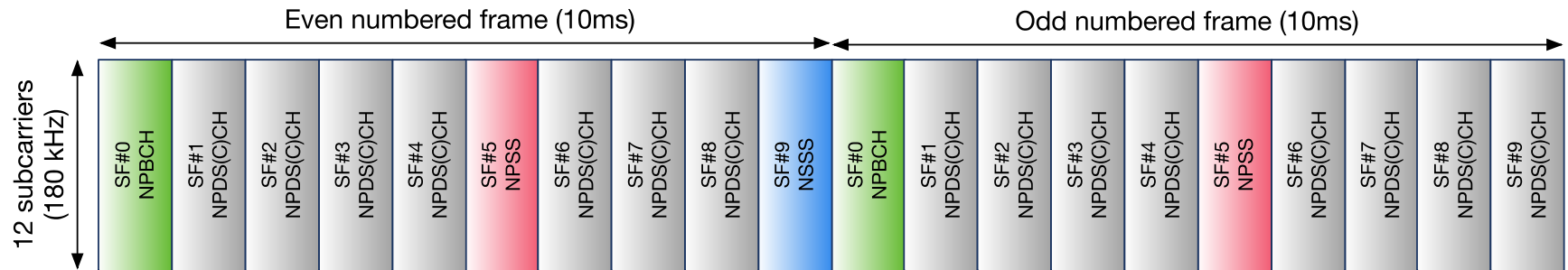
측정 화면

Measure Type: Frame

- Frame



채널 별 I-Q Diagram 측정

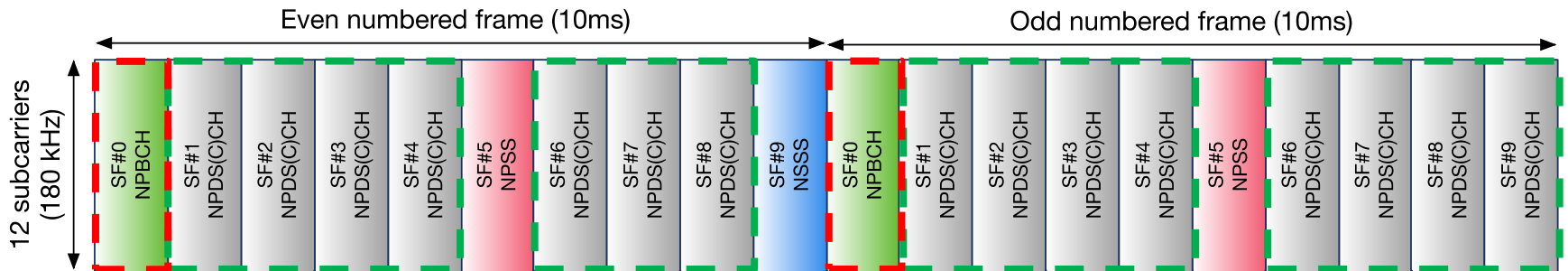
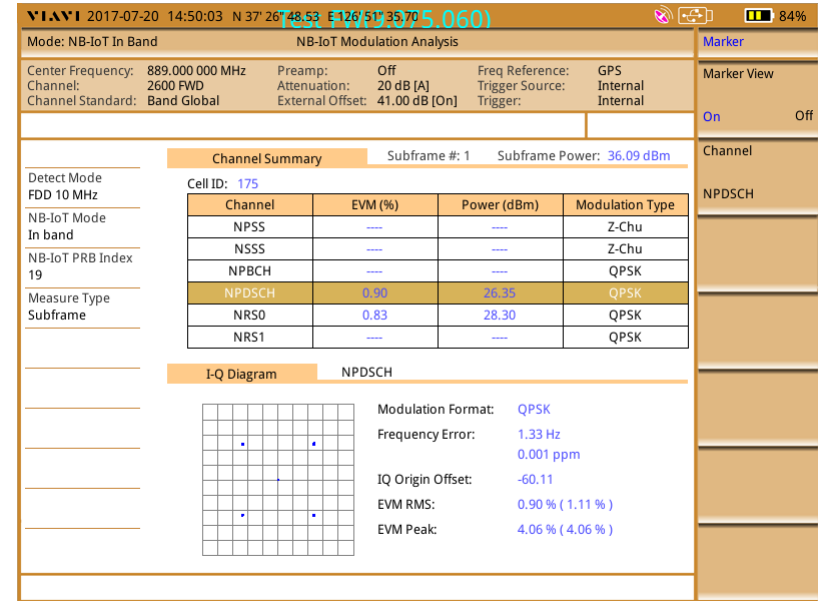
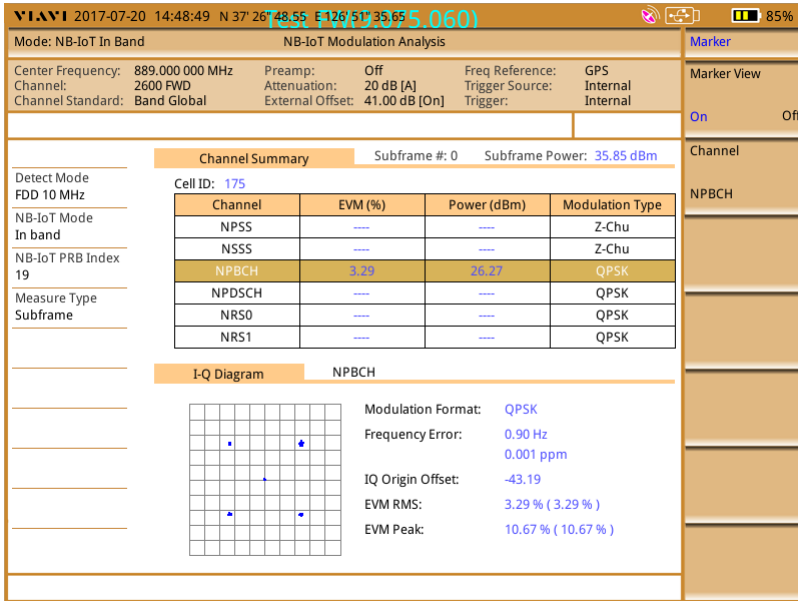


측정 화면

Measure Type: Subframe

- Subframe: #0 (NPBCH)

- Subframe: #1/2/3/4/6/7/8 (NPDSCH/RS)

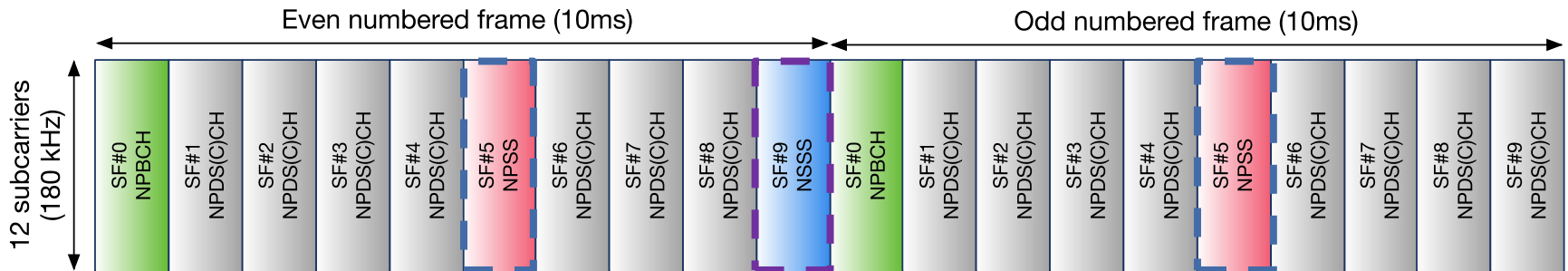
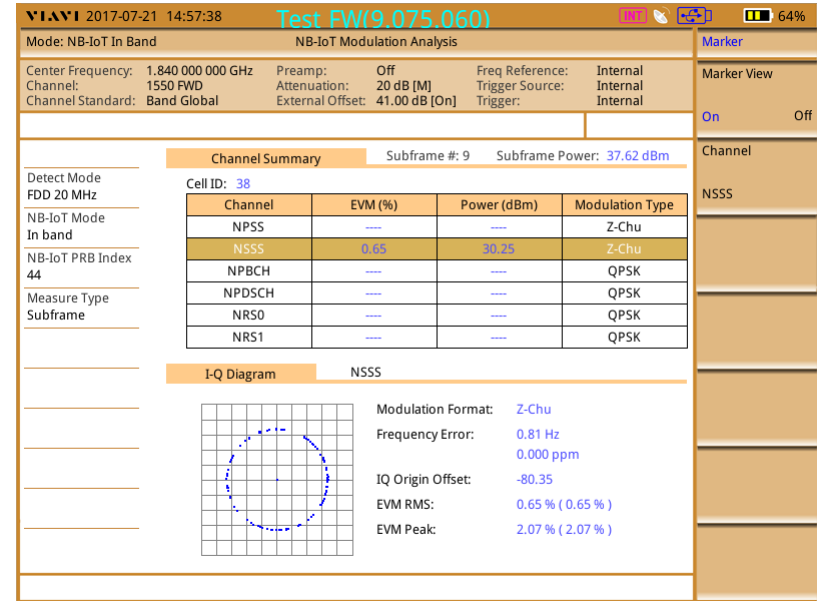
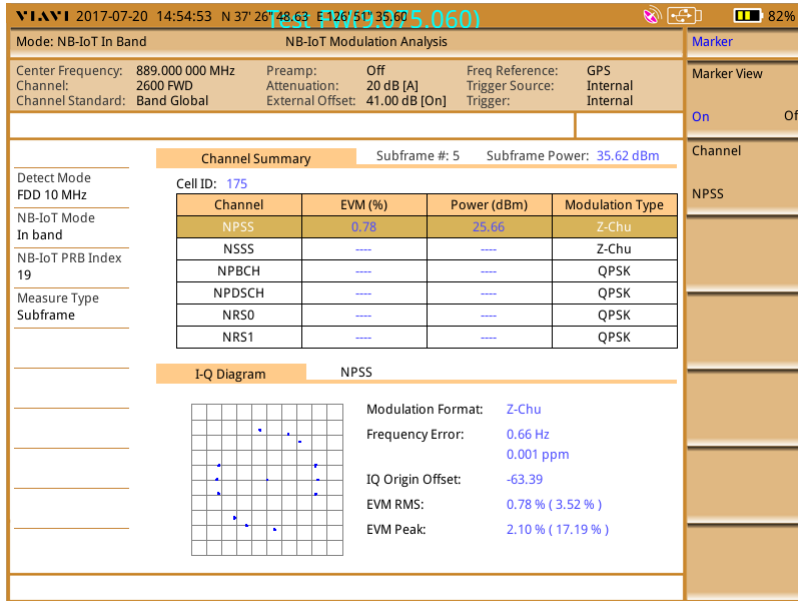


측정 화면

Measure Type: Subframe

- Subframe: #5 (NPSS)

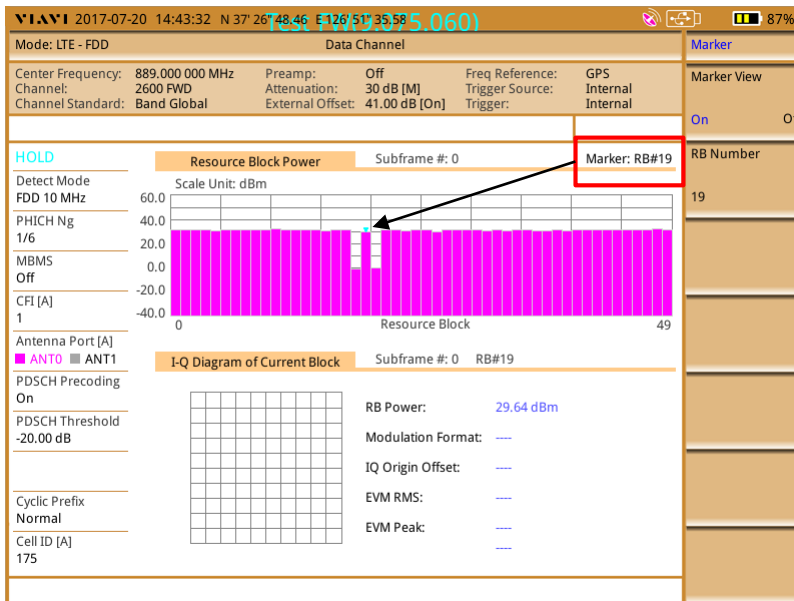
- Subframe: #9 (NSSS)



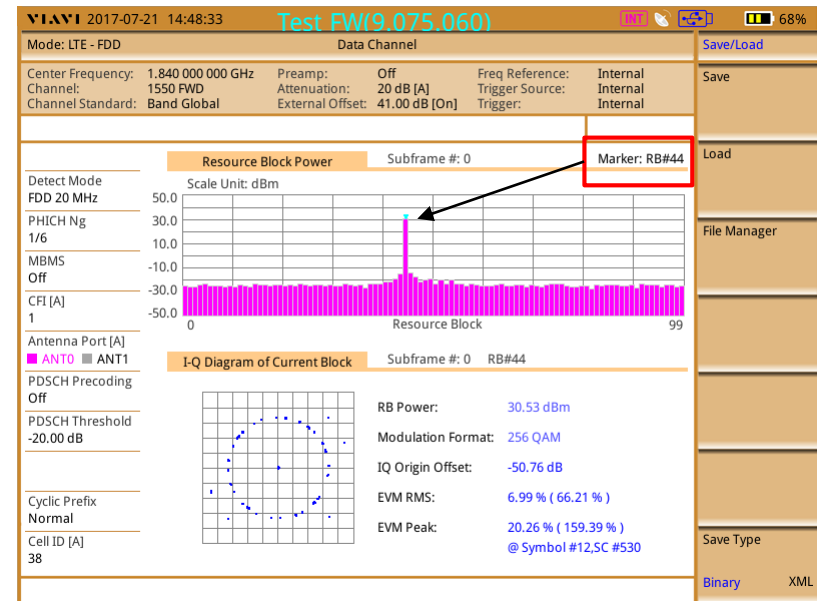
NB-IoT(In-Band) 서비스 PRB 찾기

- LTE-FDD Demodulation에서 DATA Channel을 선택하여 확인

(In-Band #19)



(In-Band #44)

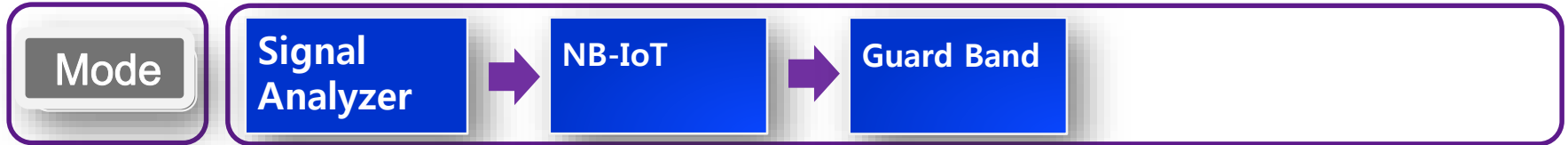


NB-IoT 측정

Guard Band

NB-IoT (Guard-Band)

• 측정 순서



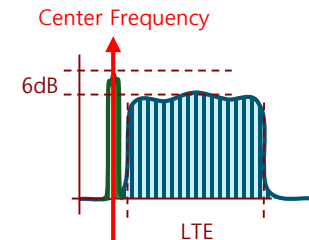
Measure Setup 4

Bandwidth
10MHz

NB-IoT (In Band)가 있는 LTE Bandwidth를 설정

NB-IoT Center
Frequency
1.000000000GHz

NB-IoT(Guard Band)의 Center Frequency를 설정 합니다.



Subframe No
0

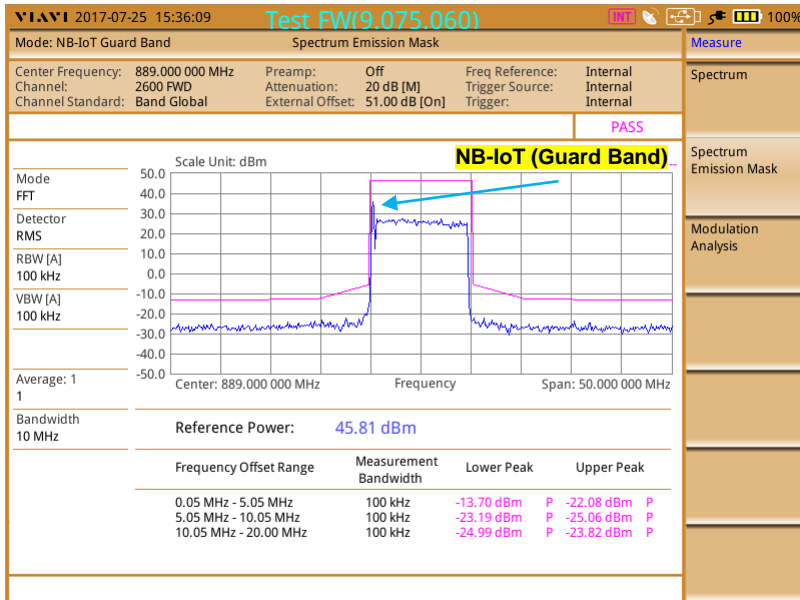
측정 할 subframe 설정. 이 메뉴는 *Measure Type* 이 subframe 일 때만 활성화 됩니다.

Measure Type
Frame Subframe

측정 결과를 Subframe 또는 Frame으로 설정할 수 있습니다.

측정 화면

• Spectrum Emission Mask



LTE-FDD 규격과 같음

E-UTRA bands <1GHz, Category B에 해당되는 Channel Bandwidth 5, 10, 15, 20 MHz 인 LTE Signal에 대한 SEM 규격

주파수 offset (RBW filter 의 -3dB point 부터)	Channel BW/2인 지점부터의 주파수 offset	요구 규격	RBW
$0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$	$0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$	-7dBm ~ -14dBm	100 kHz
$5 \text{ MHz} \leq \Delta f < 10 \text{ MHz}$	$5.05 \text{ MHz} \leq f_{\text{offset}} < 10.05 \text{ MHz}$	-14 dBm	100 kHz
$10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$	$10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$	-16 dBm	100 kHz

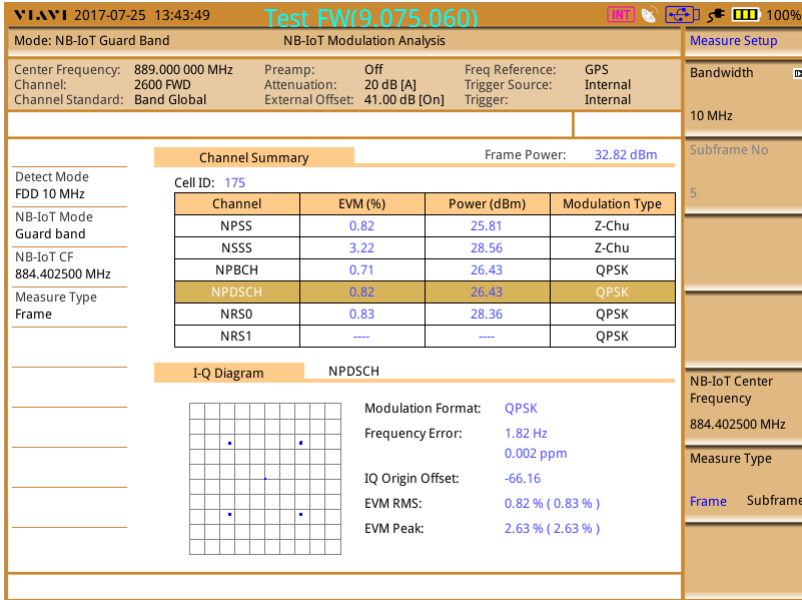
E-UTRA bands >1GHz, Category B에 해당되는 Channel Bandwidth 5, 10, 15, 20 MHz 인 LTE Signal에 대한 SEM 규격

주파수 offset (RBW filter 의 -3dB point 부터)	Channel BW/2인 지점부터의 주파수 offset	요구 규격	RBW
$0 \text{ MHz} \leq \Delta f < 5 \text{ MHz}$	$0.05 \text{ MHz} \leq f_{\text{offset}} < 5.05 \text{ MHz}$	-7dBm ~ -14dBm	100 kHz
$5 \text{ MHz} \leq \Delta f < 10 \text{ MHz}$	$5.05 \text{ MHz} \leq f_{\text{offset}} < 10.05 \text{ MHz}$	-14 dBm	100 kHz
$10 \text{ MHz} \leq \Delta f \leq \Delta f_{\text{max}}$	$10.05 \text{ MHz} \leq f_{\text{offset}} < f_{\text{offset}_{\text{max}}}$	-16 dBm	1 MHz

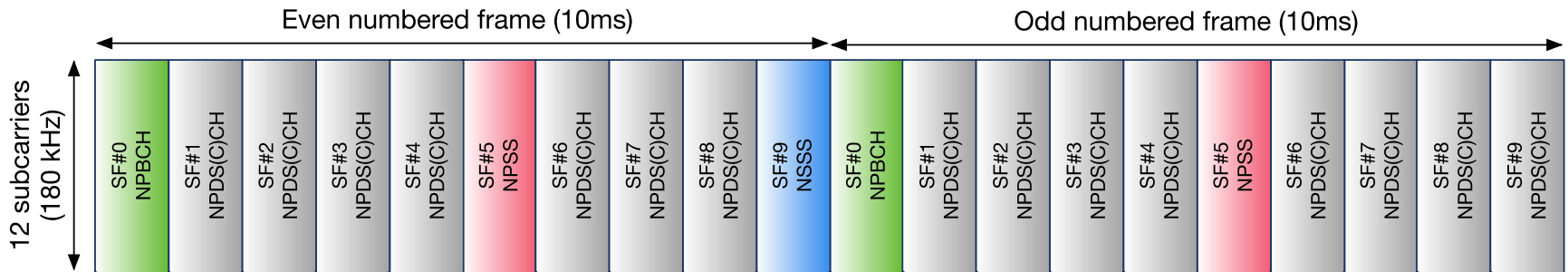
측정 화면

Measure Type: Frame

- Frame



채널 별 I-Q Diagram 측정

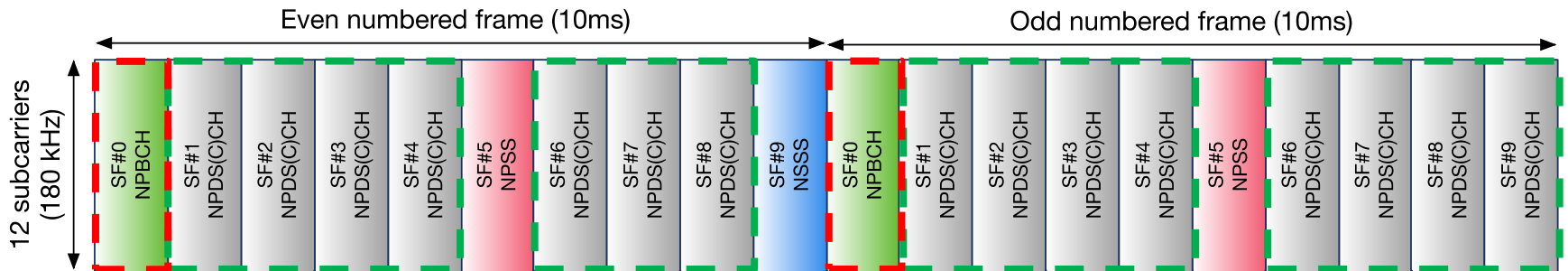
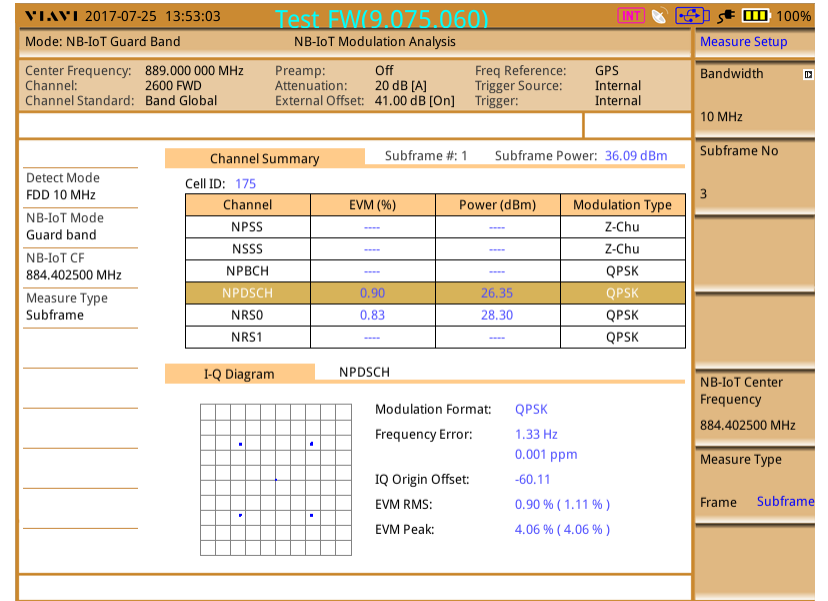
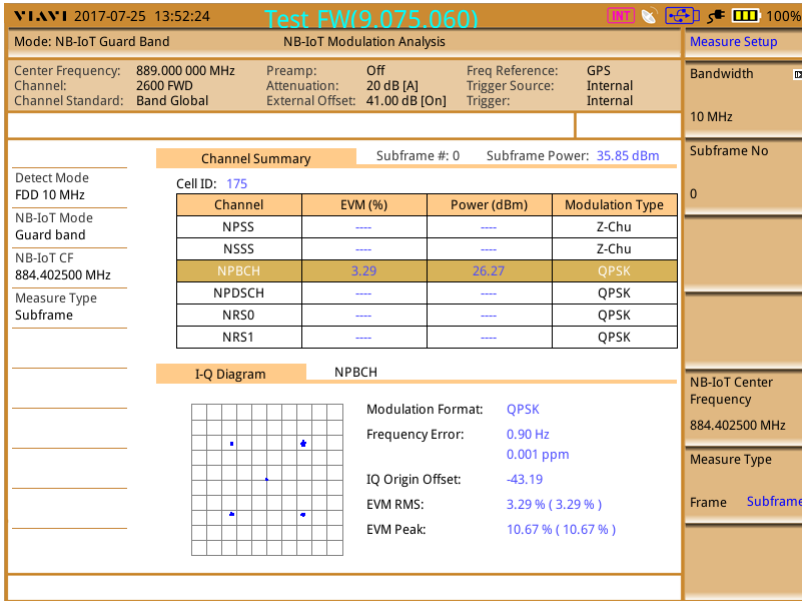


측정 화면

Measure Type: Subframe

- Subframe: #0 (NPBCH)

- Subframe: #1/2/3/4/6/7/8 (NPDSCH/RS)

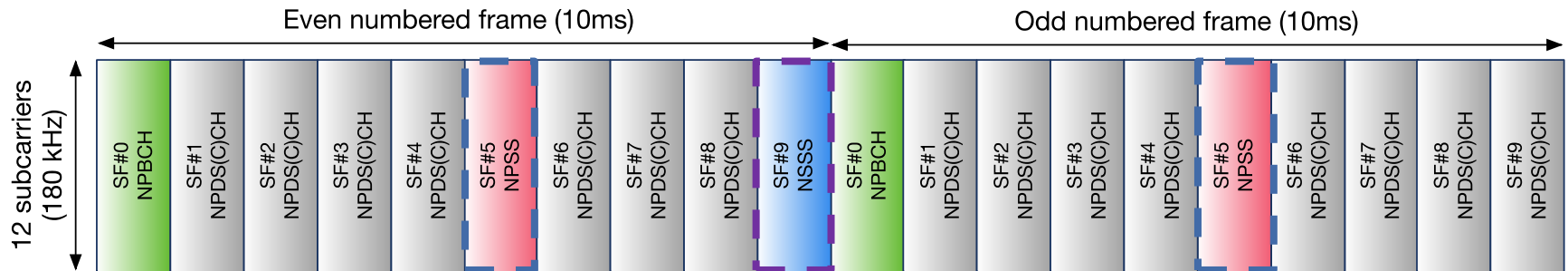
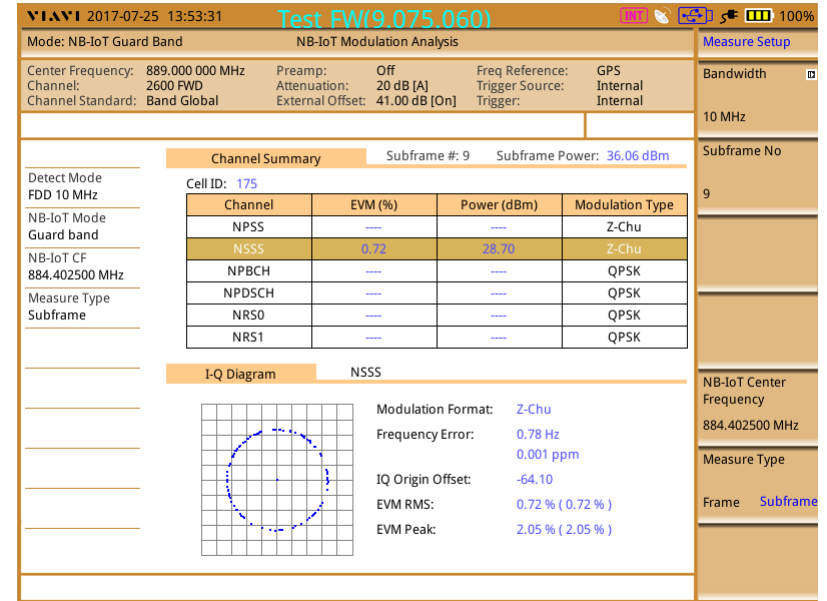
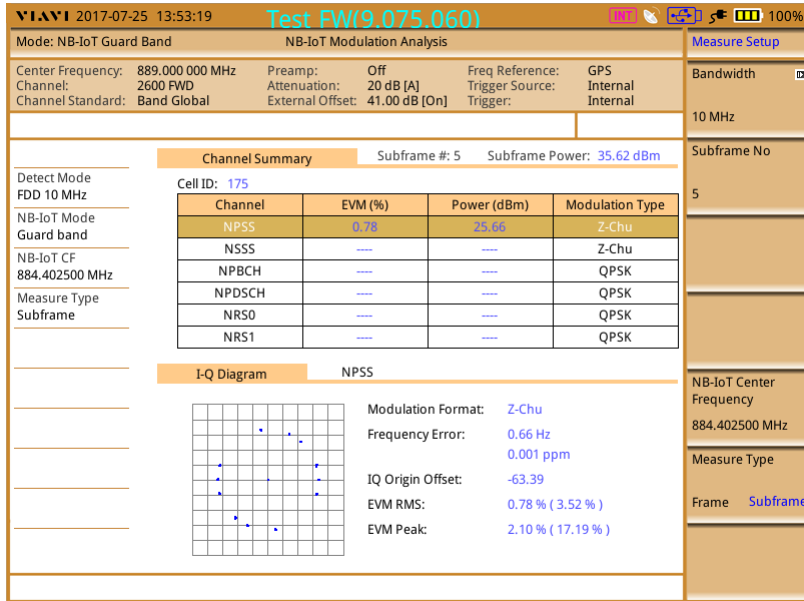


측정 화면

Measure Type: Subframe

- Subframe: #5 (NPSS)

- Subframe: #9 (NSSS)

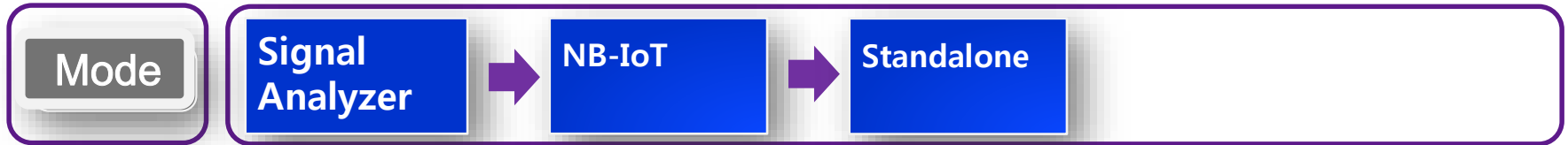


NB-IoT 측정

Standalone

NB-IoT (Standalone)

· 측정 순서



Measure 1

RF Analysis Channel Power, Occupied BW, Spectrum Emission Mask, ACLR, Spurious Emissions

Modulation Analysis Subframe 또는 Frame을 설정하여 측정

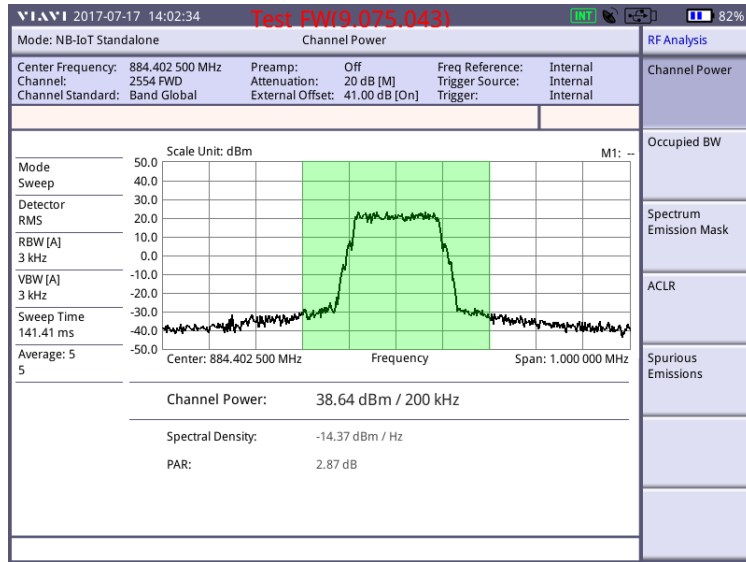
Measure Setup 4

Subframe No 0 측정 할 subframe 설정. 이 메뉴는 *Measure Type* 이 subframe 일 때만 활성화 됩니다.

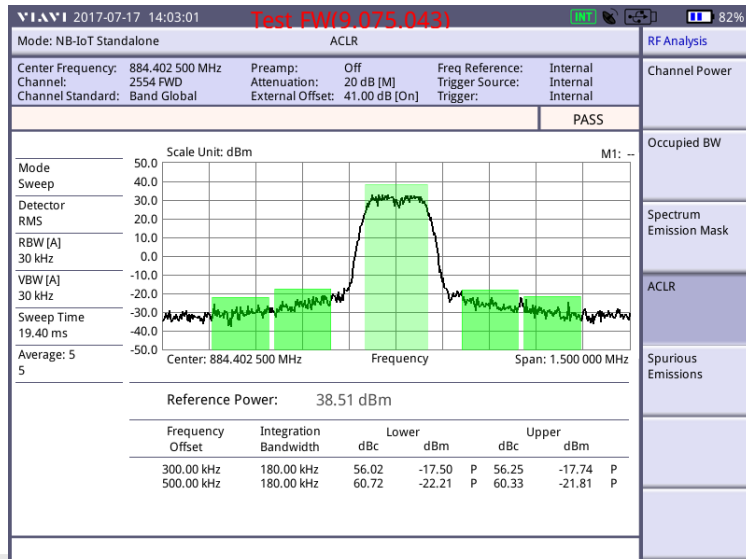
Measure Type
Frame Subframe 측정 결과를 Subframe 또는 Frame으로 설정할 수 있습니다.

측정 화면

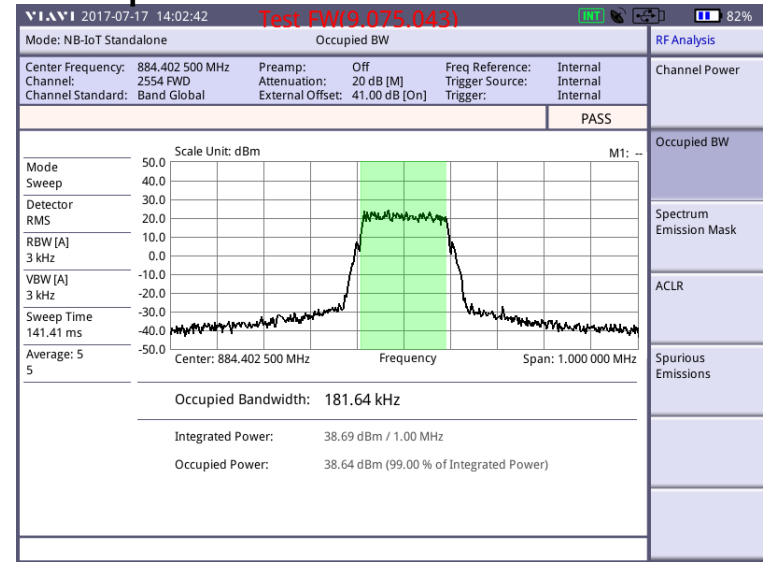
• Channel Power



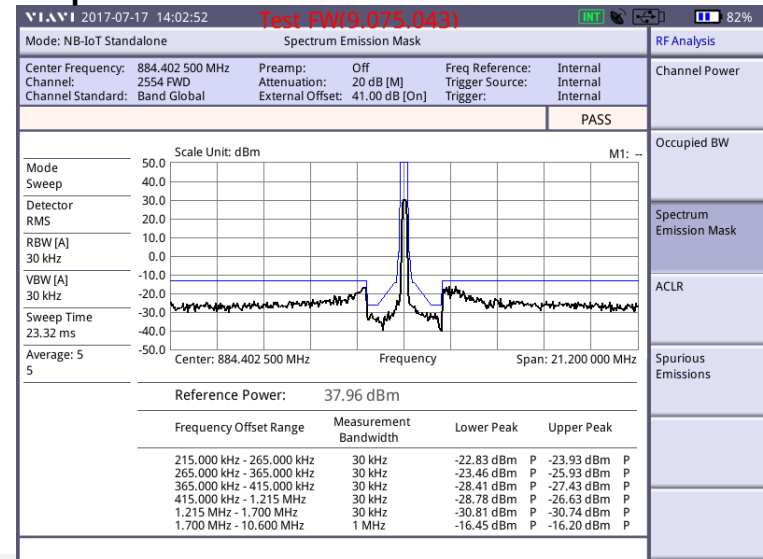
• ACLR



• Occupied BW



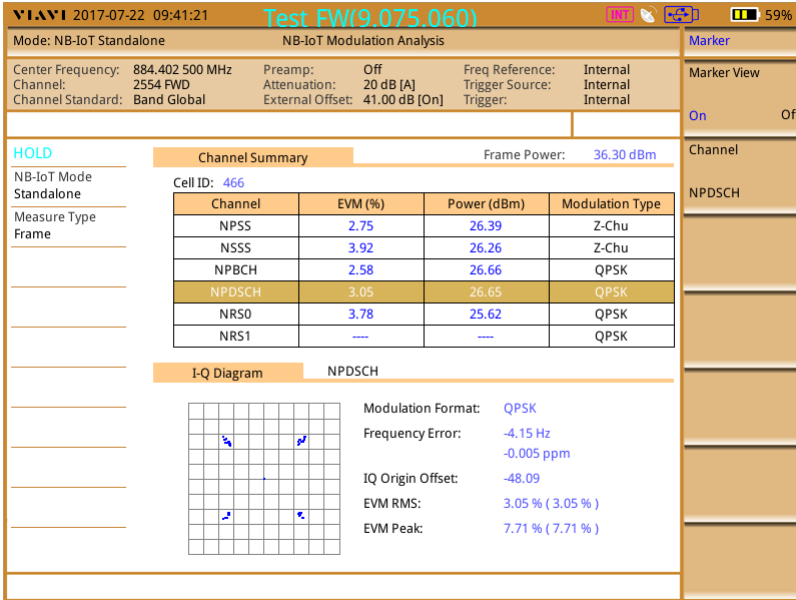
• Spectrum Emission Mask



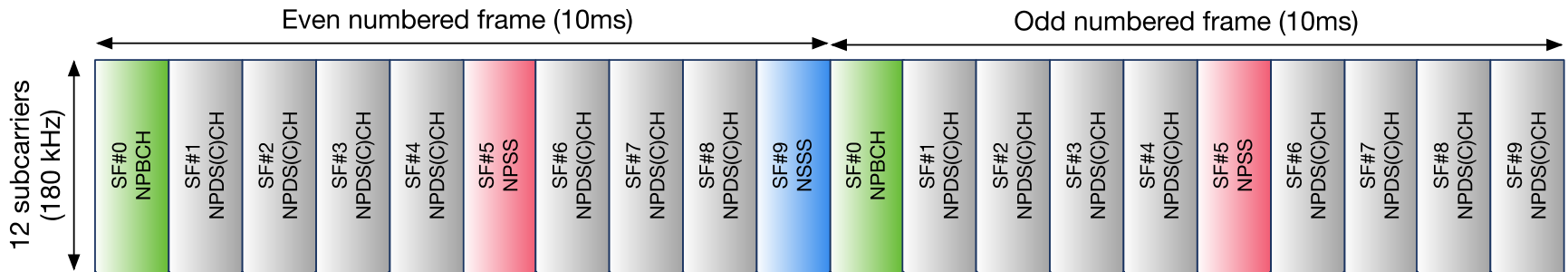
측정 화면

Measure Type: Frame

- Frame



채널 별 I-Q Diagram 측정

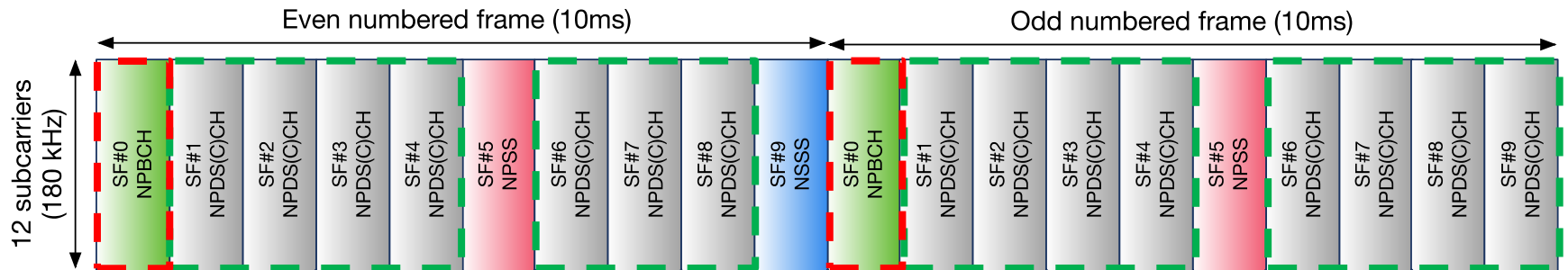
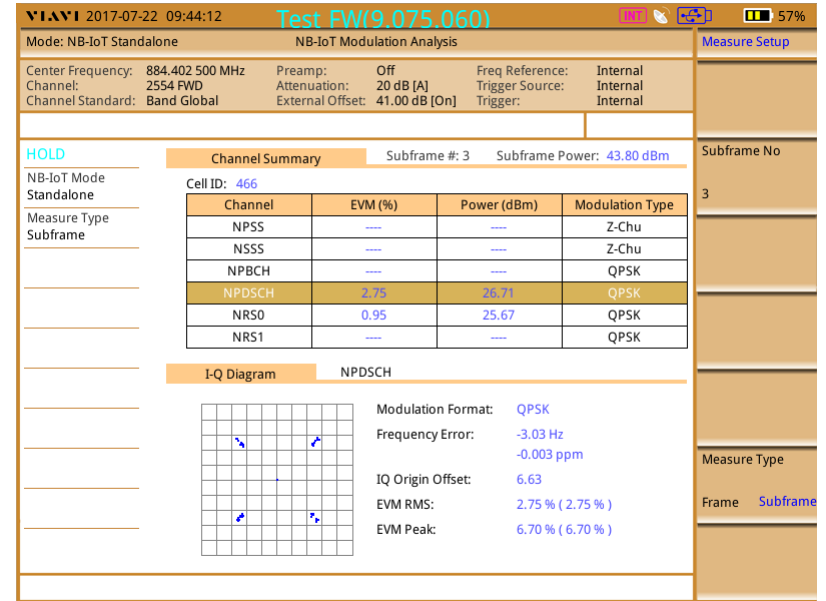
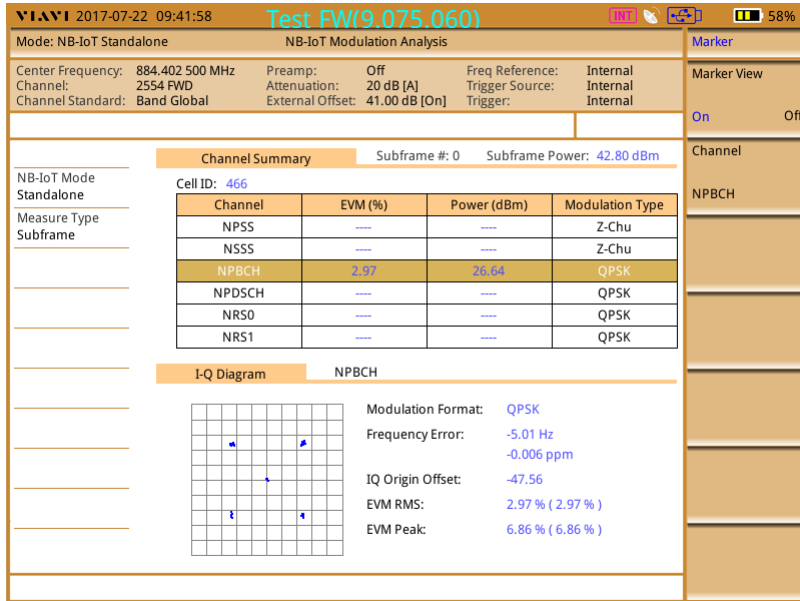


측정 화면

Measure Type: Subframe

- Subframe: #0 (NPBCH)

- Subframe: #1/2/3/4/6/7/8 (NPDSCH/RS)

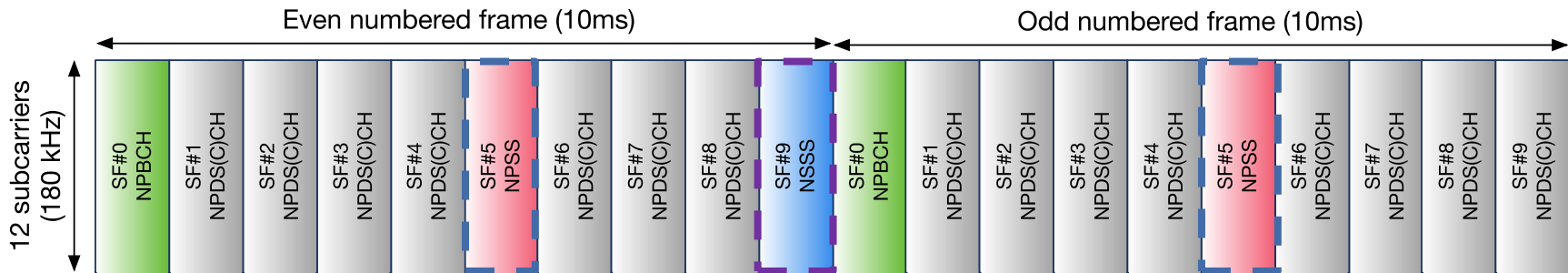
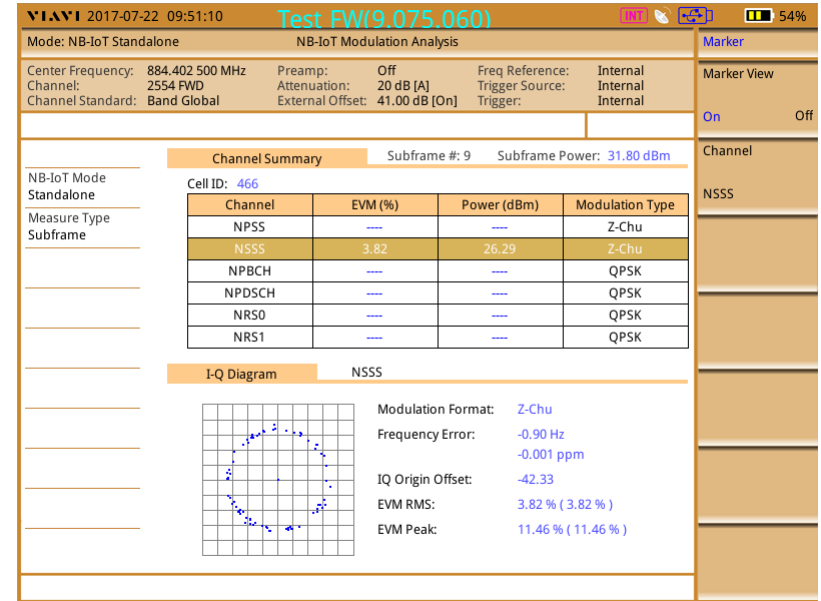
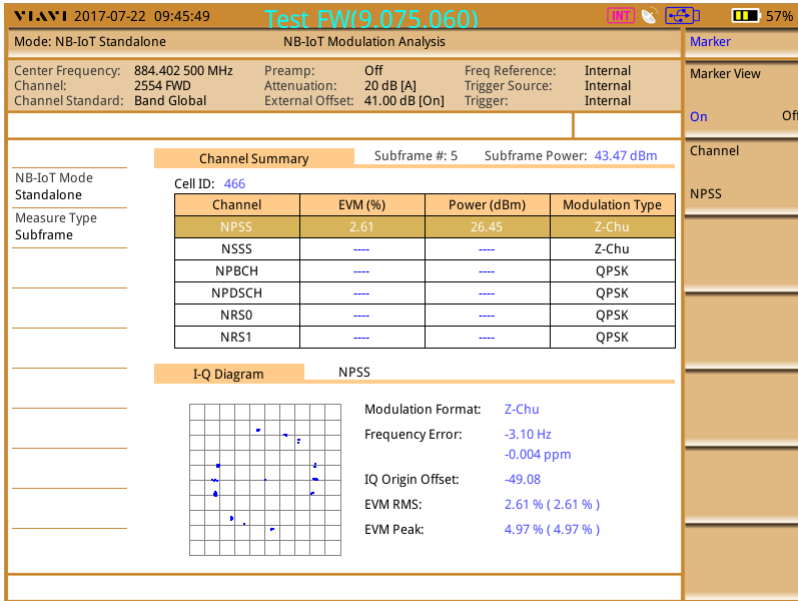


측정 화면

Measure Type: Subframe

- Subframe: #5 (NPSS)

- Subframe: #9 (NSSS)





VI.VI

비아비솔루션스

영업 : TEL: 02-6676-7024

기술지원 : TEL: 02-6676-7012

CellAdvisor product site:

<http://celladvisor.updatemyunit.net/>

www.viavisolutions.com