

# Methods and tools for measurement of real power consumption of battery powered RF devices

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# H TEST introduction

- **H TEST a.s.**

Founded August 1999

Praha, CZECH REPUBLIC

- **H TEST SLOVAKIA spol. s r.o.**

Founded September 2001

Banská Bystrica, SLOVAKIA

- **x.test GmbH**

Founded April 2010

Wien, AUSTRIA

- **H TEST Hungary Kft**

Founded June 2013

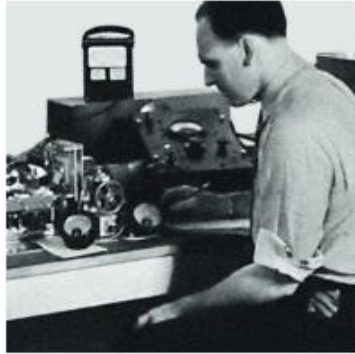
Gyor, HUNGARY



Team of 30 employees located in four sales offices

# H TEST – Keysight technologies

From Hewlett-Packard through Agilent to Keysight



1939

THE FUTURE

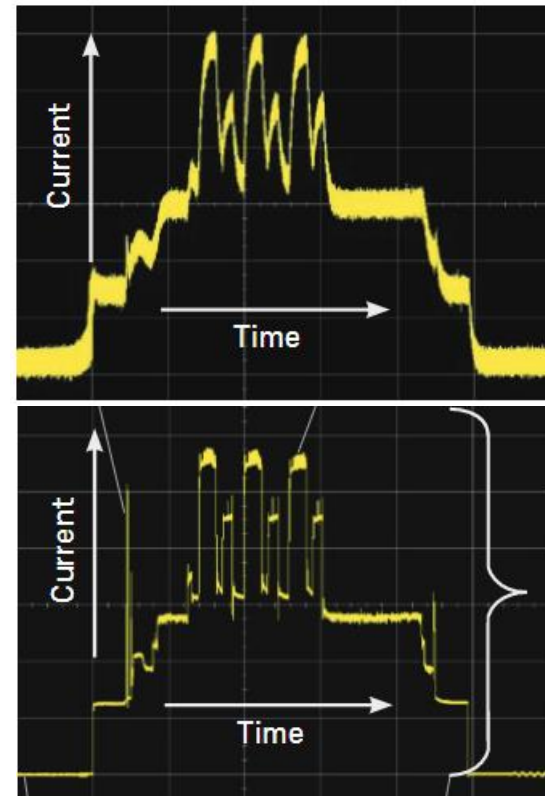
**HARDWARE + SOFTWARE + PEOPLE = INSIGHTS**

	Electronic Design Automation
	Network Analyzers
	Signal Analyzers
	Signal Sources
	Oscilloscopes
	One Box Testers

# Low current measurement difficulties

IoT battery powered products requires low power consumption

- Limited dynamic range
- Large measurement noise
- Limited bandwidth
- Multiple instrument needed



# Current measurement possibilities

- 1) Multimeter
- 2) Scope + current probe/shunt resistor
- 3) Power analyzer Keysight N6705B+N6781A

# 1) Multimeter Keysight 34470A

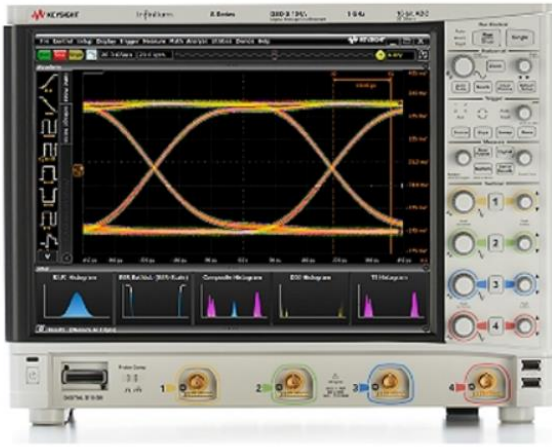
- Resolution: up to 7 ½ digits
- Bandwidth: 10 kHz
- Sample rate: 50 kSa/s
- Measurement time: 40s/PC unlimited
- Measurement range: 50 pA – 10 A
- Dynamic range: 60-75 dB
- Accuracy: 0,05 %
- Noise: about 50 pA at 1 uA range
- Price: 1200 – 2500 Euro



# 2) Scope + current probe/shunt

## Infinium S-Series

- 10 bit, low noise



## 1147B

- 15 A, 50 MHz



## N2820A

- 2 channel, 5A, 3 MHz



## 2) Scope + N2820A

- Two signal path with different gain
  - wide dynamic range
- Bandwidth 3 MHz / 500 kHz
- 3 replaceable shunt heads
  - 20 m $\Omega$  – current 250  $\mu$ A to 5 A
  - 100 m $\Omega$  – current 50  $\mu$ A to 2.2 A
  - User defined – from 1 m $\Omega$  to 1 M $\Omega$





## 2) Scope + N2820A

- Resolution: 10 bits
- Bandwidth: 3 MHz / 500 kHz
- Sample rate: ~GSa/s
- Measurement time: ~ms
- Measurement range: 50  $\mu$ A – 5 A
- Dynamic range: 85 dB
- Accuracy: 2 %
- Noise: 50  $\mu$ A
- Price: probe 3700 Euro



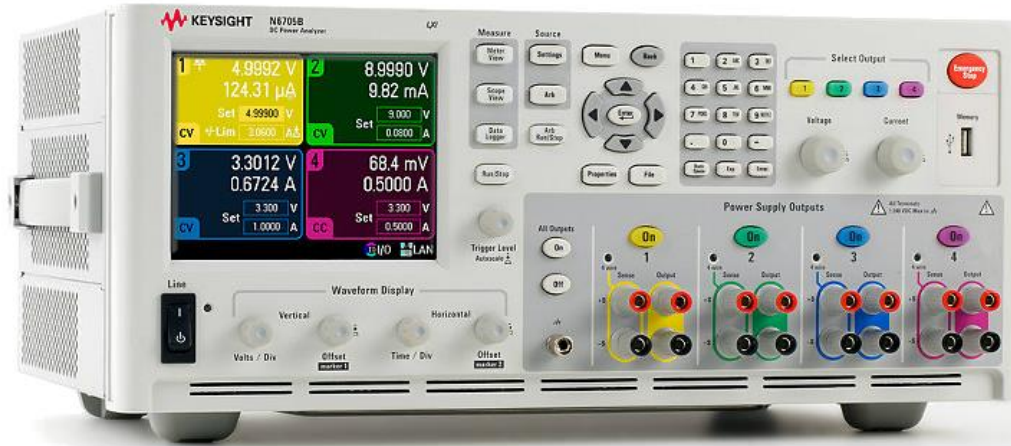
# 3) Dedicated SMU



N6781A  
(20 W)



N6785A  
(80 W)

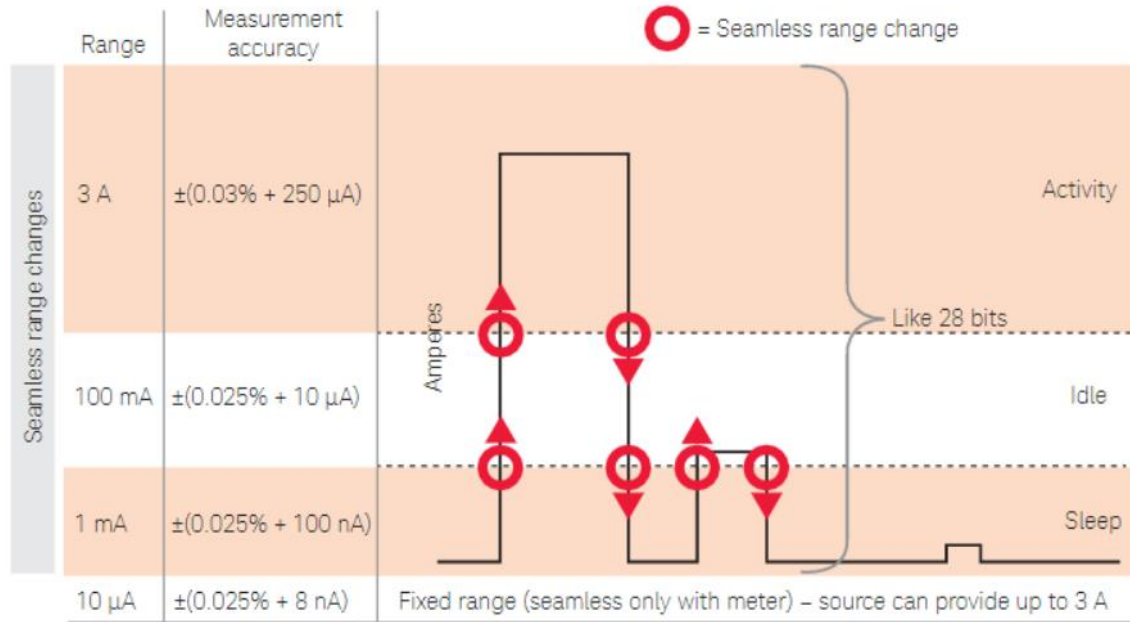


N6705B  
(up to 4 modules)

# 3) Dedicated SMU

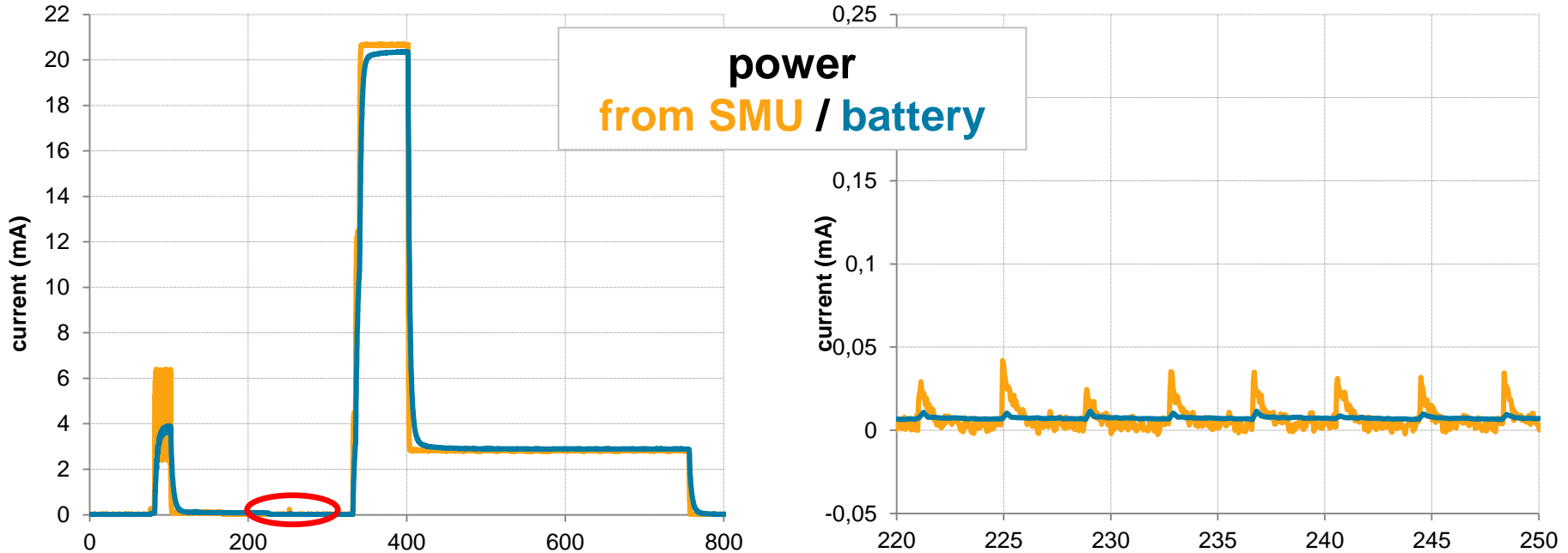
## Simultaneous „seamless“ ranging

- Autoranging with zero delay
- Enhance effective resolution to 28 bits



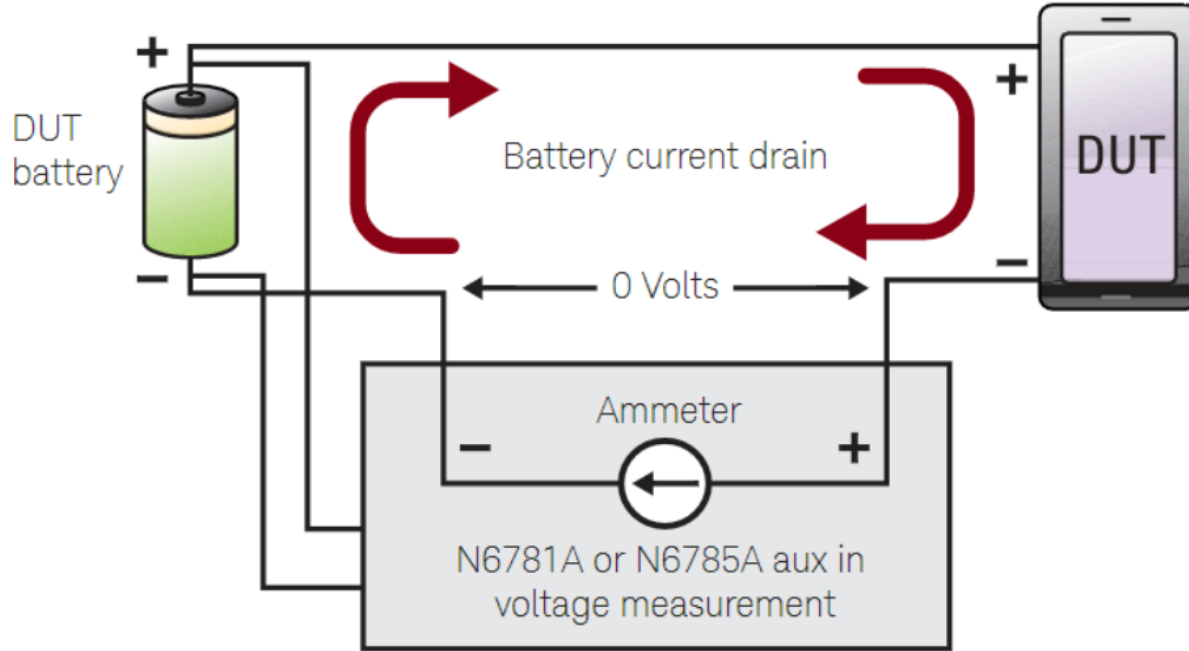
# 3) Dedicated SMU

- Battery emulation mode – internal resistance emulation



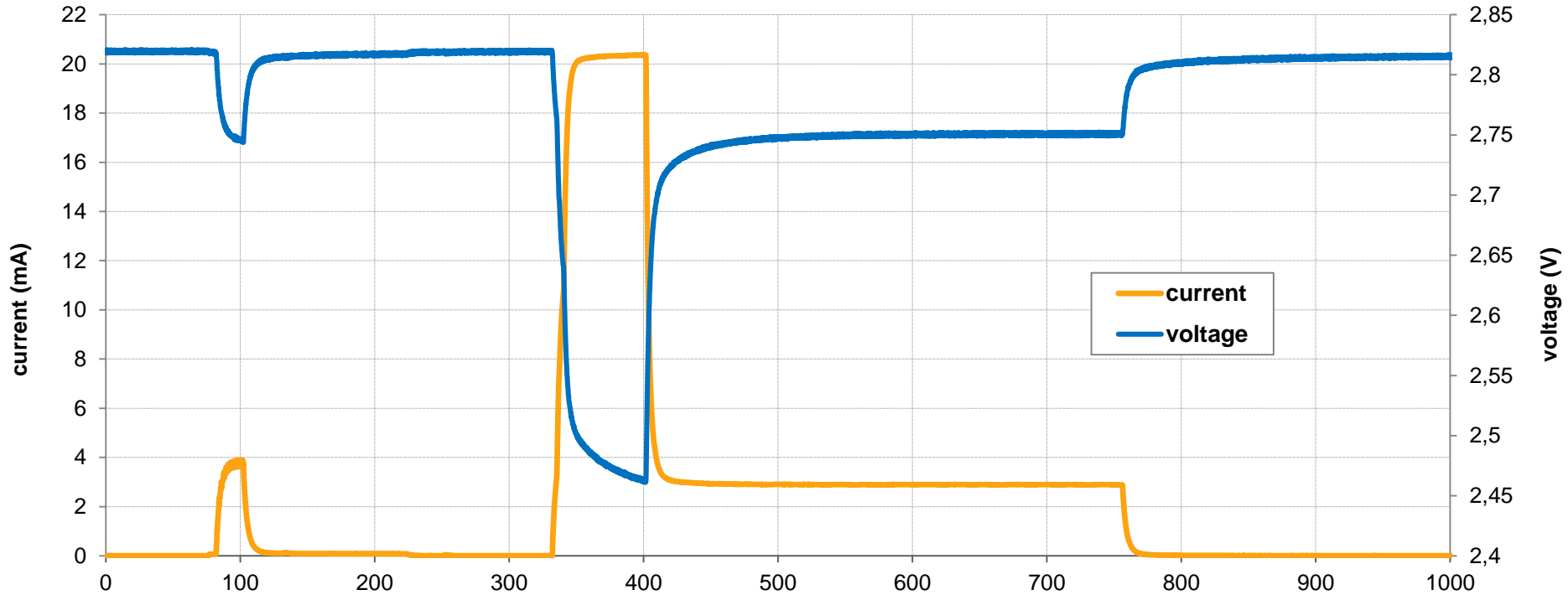
# 3) Dedicated SMU

Voltage and current measurement on battery powered device



# 3) Dedicated SMU

Voltage and current measurement on battery powered device



# 3) Dedicated SMU N6781A

- Resolution: 28 bit
- Bandwidth: 100 kHz
- Sample rate: 200 kSa
- Measurement time: 1000 hours
- Measurement range: 8 nA, 100 nA – 3 A
- Dynamic range: 150 dB
- Accuracy: 0,03 %
- Noise: 8 nA, 100 nA
- Price: 7400 – 11800 Euro

## Advanced features:

- Simultaneous V, I measurement
- Seamless ranging
- Battery resistance emulation
- 2-quadrant operation
- Arbitrary voltage operation

# Example of real measurement

DUT – IQRF TR-76D series

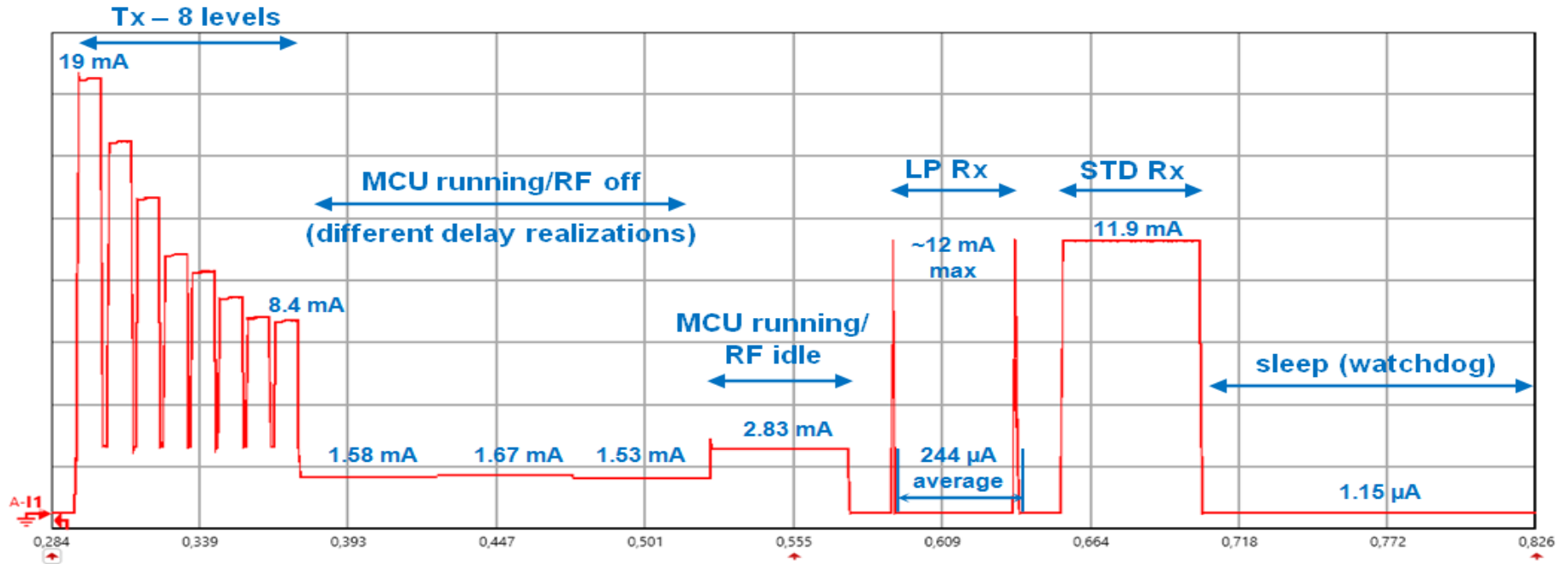
- RF modulation: GMSK
- RF bands: 868 MHz
- RF output power: 12.5 mW in 8 steps
- Range: 500 m ~19 kb/s, in free space
- MCU clock: 16 MHz
- Serial EEPROM: 32 KB
- Integrated antenna





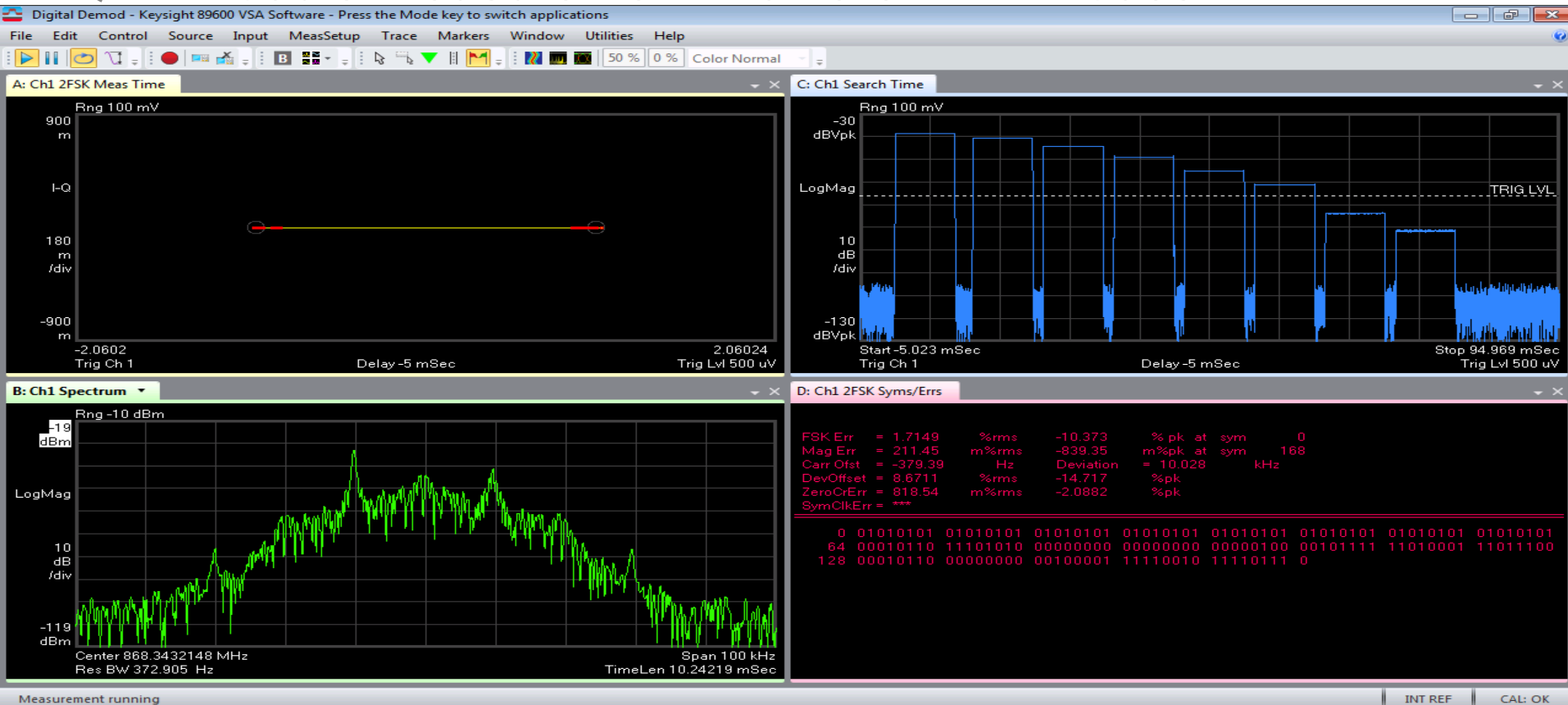
# Current measurement with N6781A

IQRF module measurement – different modes



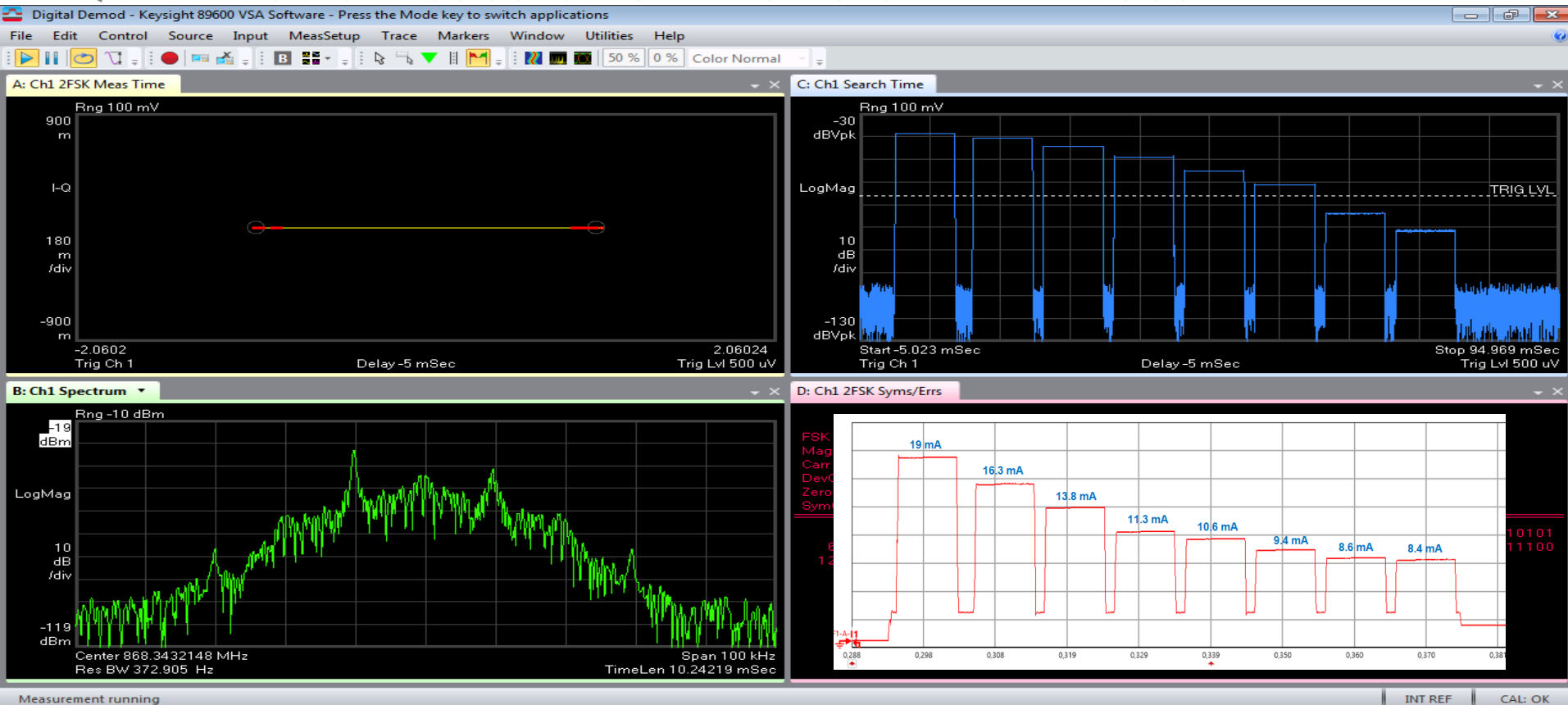
# Vector Signal Analyzer measurement

## IQRF module measurement – different TX modes



# Vector Signal Analyzer measurement

## IQRF module measurement – different TX modes



# Conclusion

Measurement challenges solved  
N6705B+N6781A

- ✓ Superior dynamic range
- ✓ Low measurement noise
- ✓ Sufficient bandwidth
- ✓ Single instrument needed

