

# WIRELESS CHARGING SOLUTION FOR AUTOMOTIVE

MARTIN MOSTEK AND THE WCH TEAM

2023-11-28



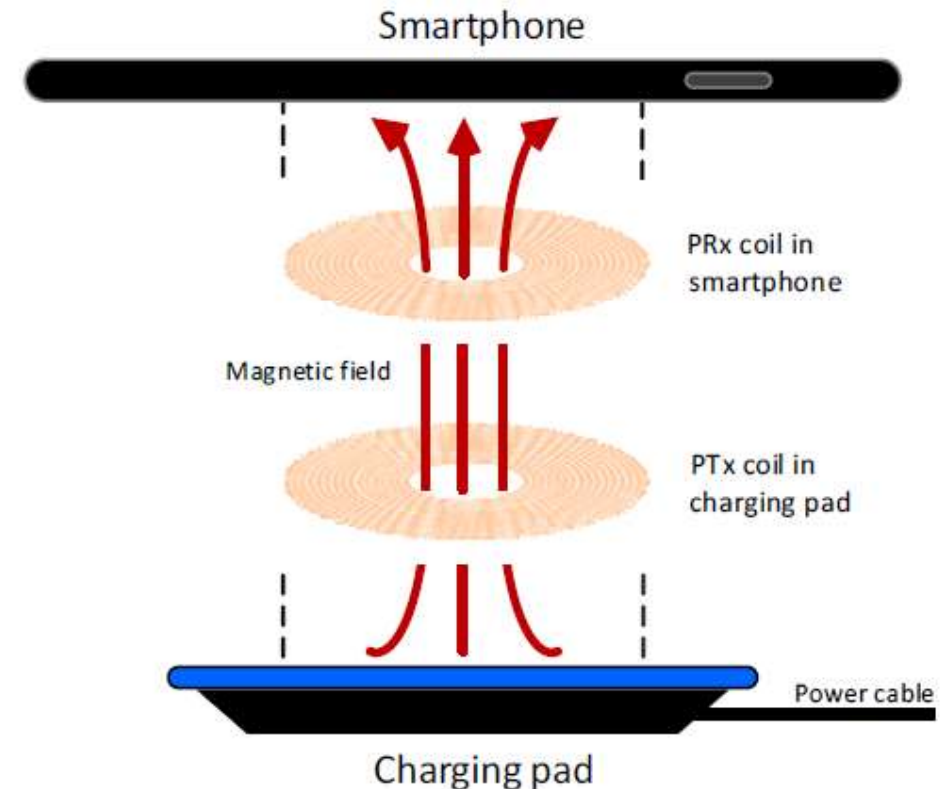
EXTERNAL USE



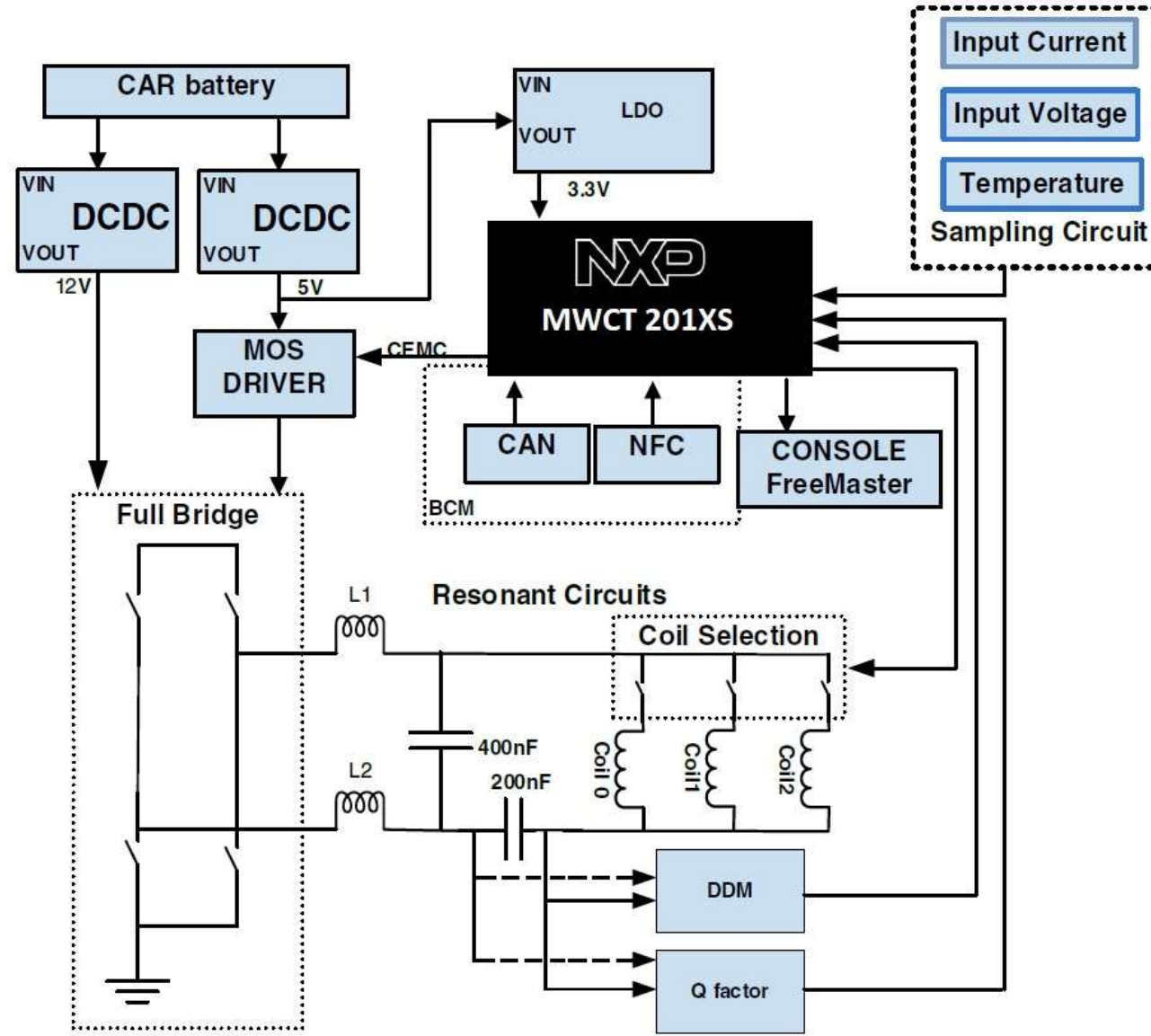
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# Wireless Charging Technology

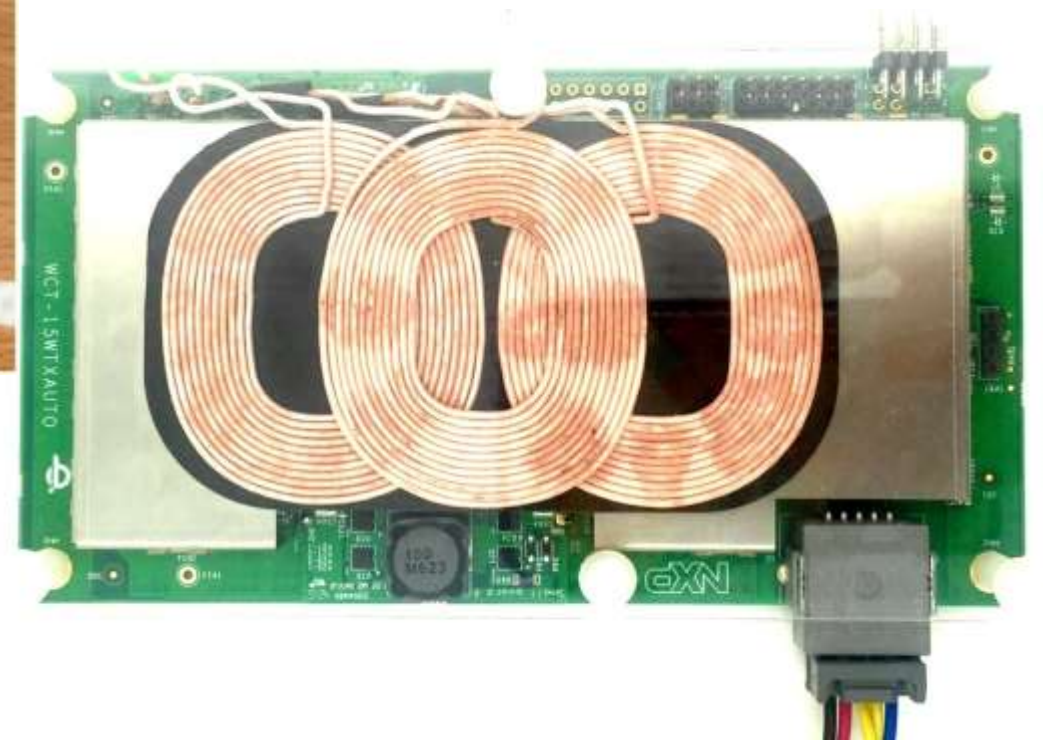
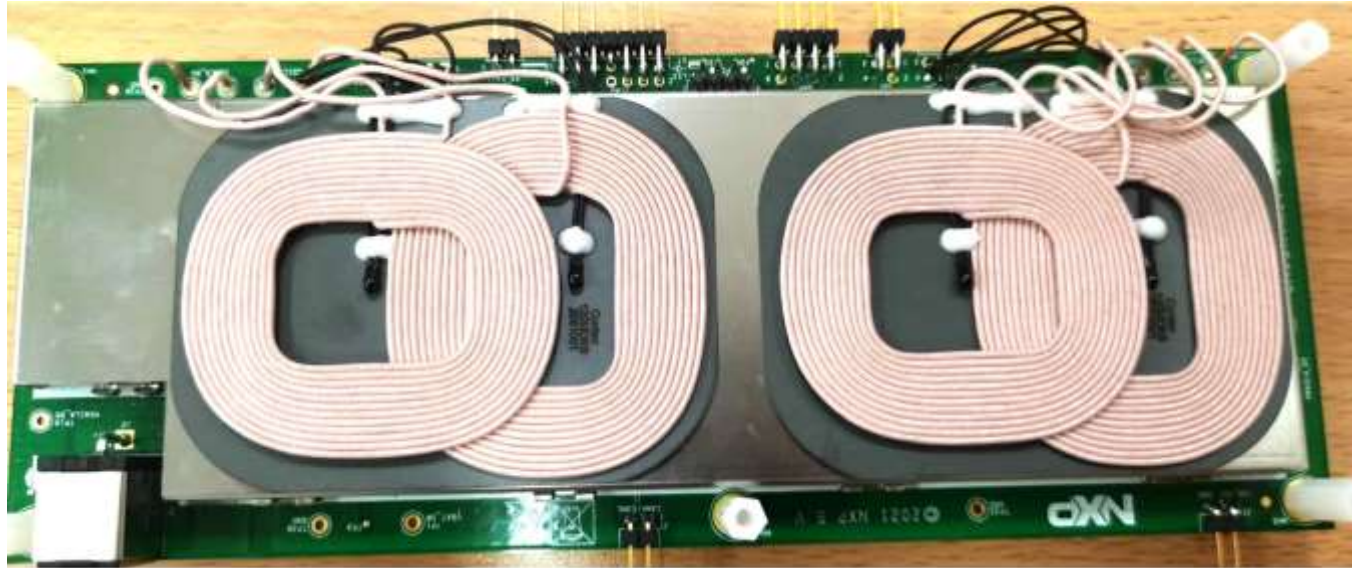
- Wireless charging is a technology which allows you to charge a device, like your smartphone, watch etc. without use of a charging cable.
- The concept, known as inductive charging, allows electricity to be transmitted through the air by the magnetic field.
- A transmitter creates an oscillating magnetic field with a receiver.
- Basic technology has been known for over a century and is more known because of the mobile cell phones technology.
- The Wireless charging standard (Qi) has been defined for standardization of the method.



# Wireless Charging Transmitter



# Single and Double WCH Transmitter



# Communication essential (In band communication)

## Receiver to Transmitter (127.772 kHz)

ASK (Amplitude Shift Keying)

Speed: 2 K bit/s

Bit-encoding: bi-phase

Byte encoding:

Start-bit, 8-bit data, parity-bit, stop-bit

Packet structure:

Preamble (>= 11bit)

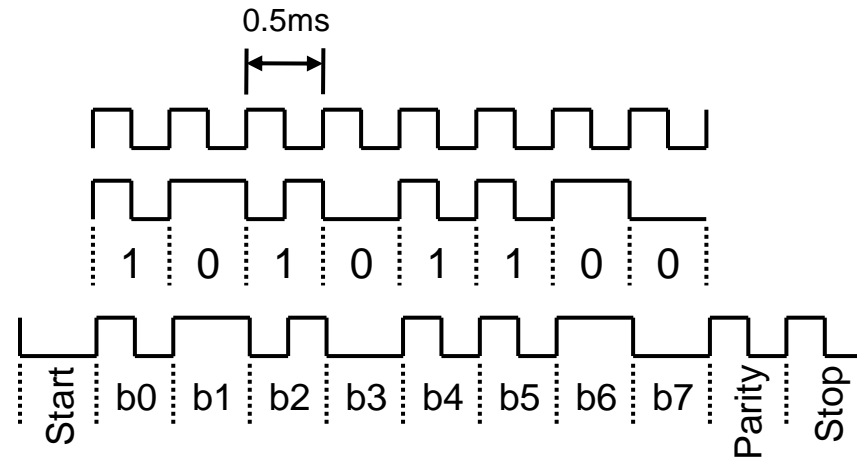
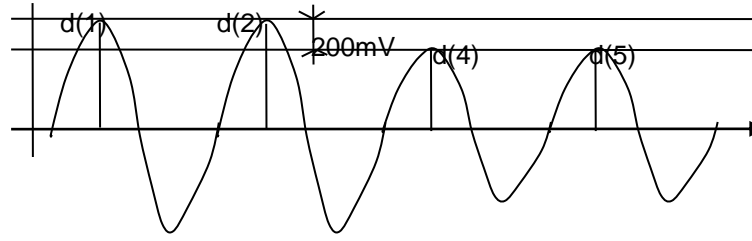
Header (1 Byte): Indicates packet type and message length

Message (1 .. 27 Byte):

One complete message per packet

Payload for control

Checksum (1 Byte)

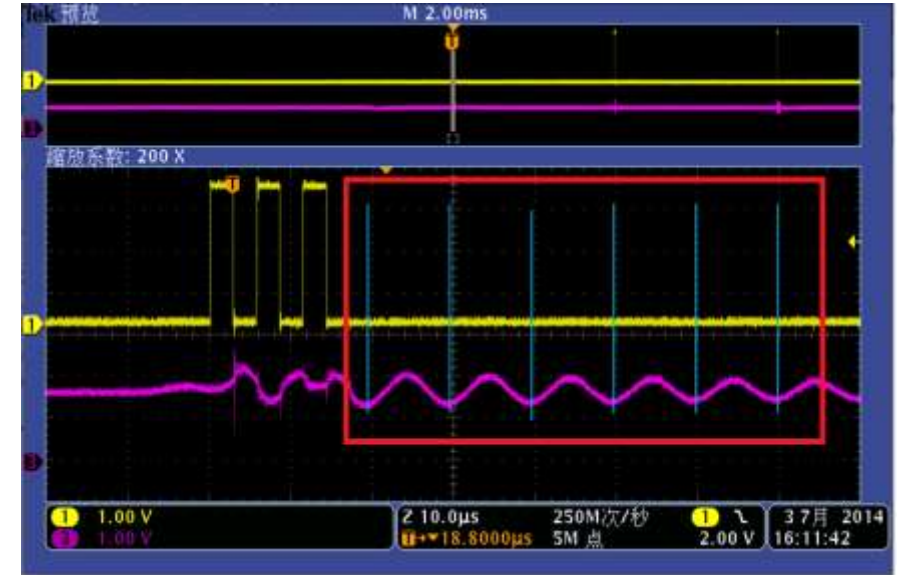
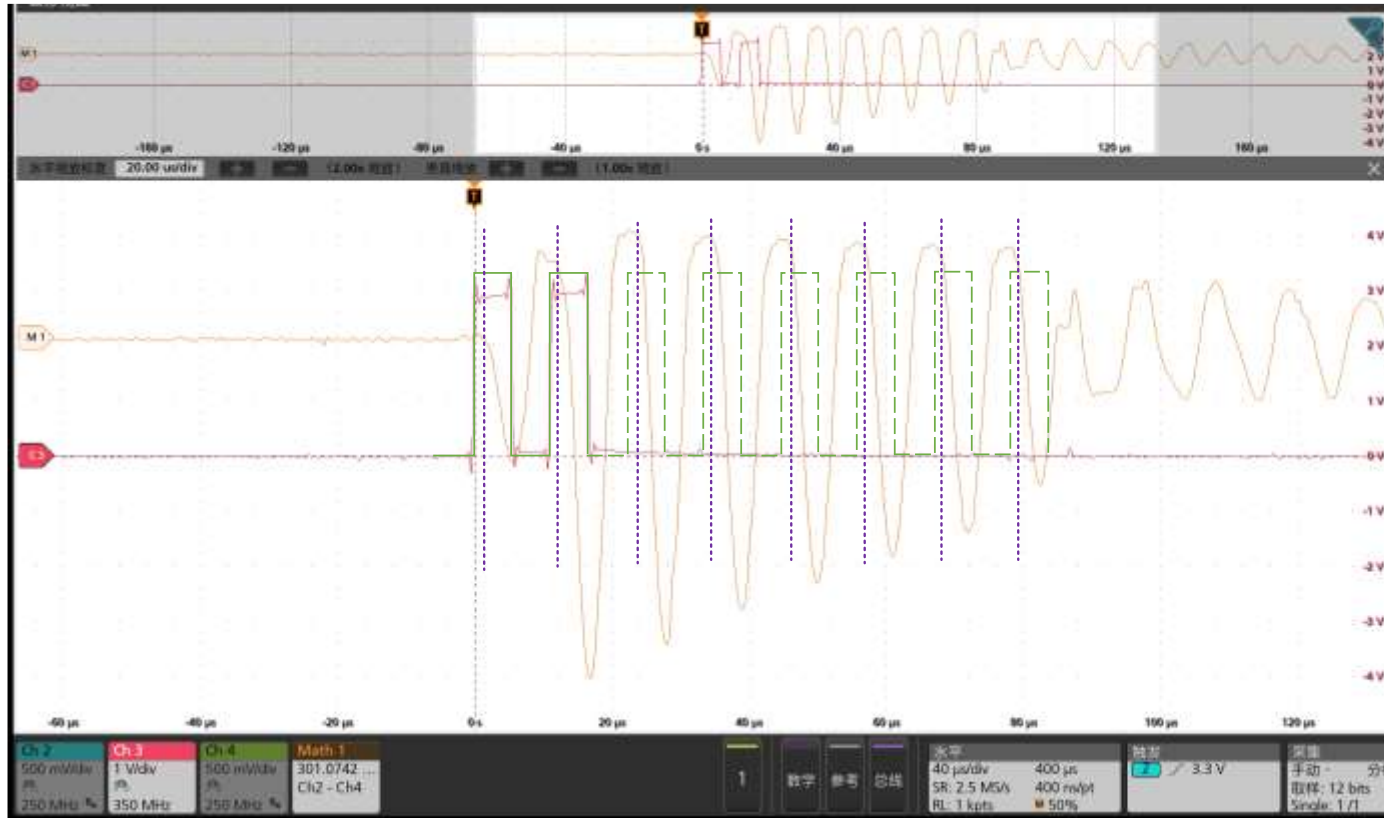


## Transmitter to Receiver (EPP only)

FSK (Frequency Shift Keying)

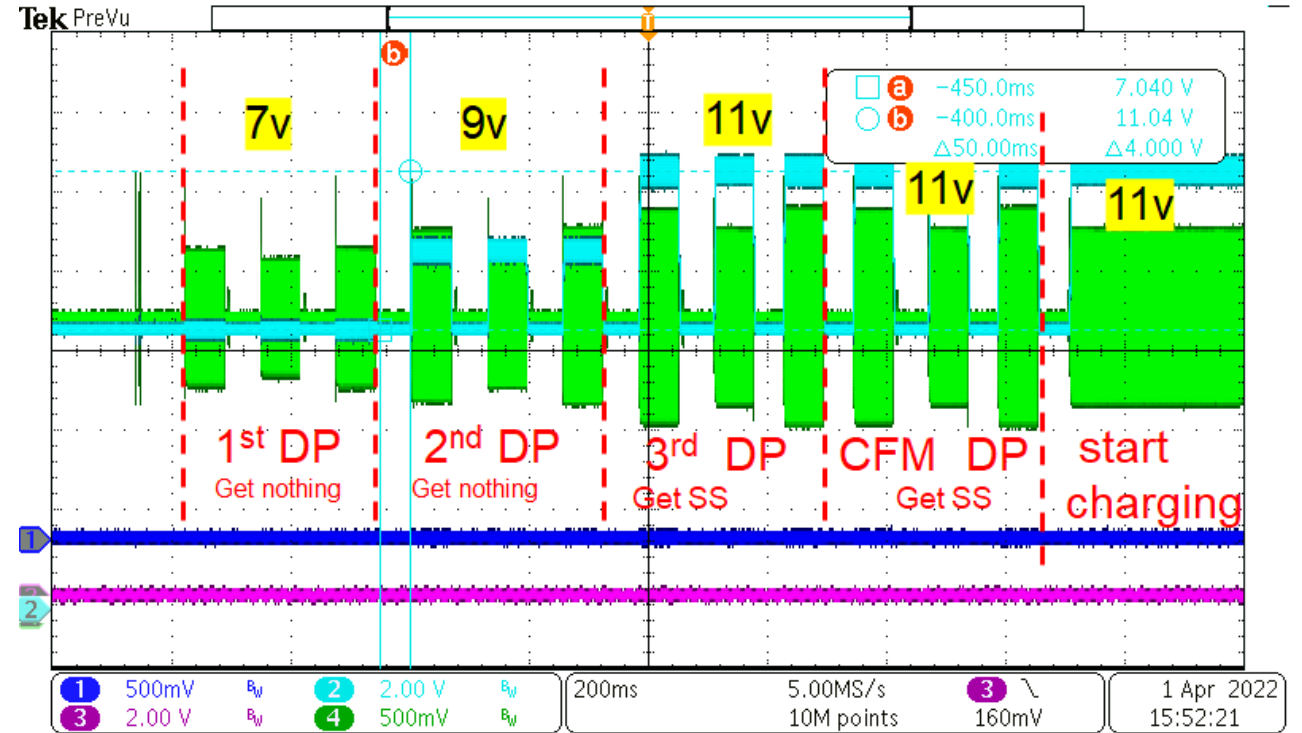
# Receiver detection - Analog Ping

- Is used for WCH Receiver detection
- It consumes a very small amount of energy
- Amplitude change or phase shift is checked during sampling



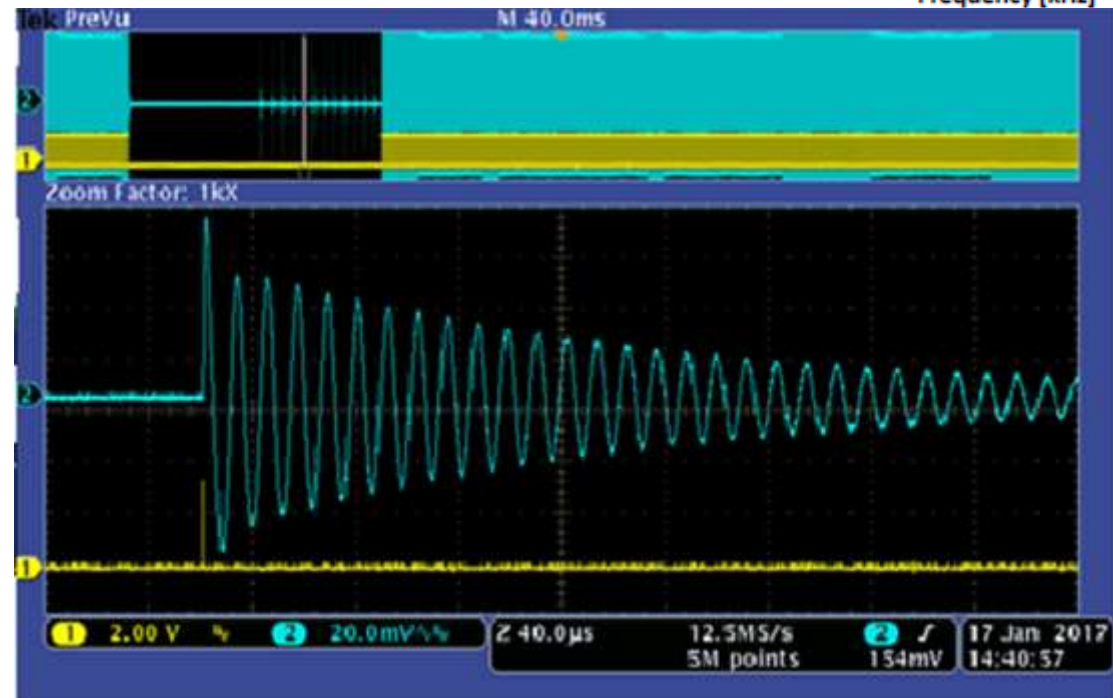
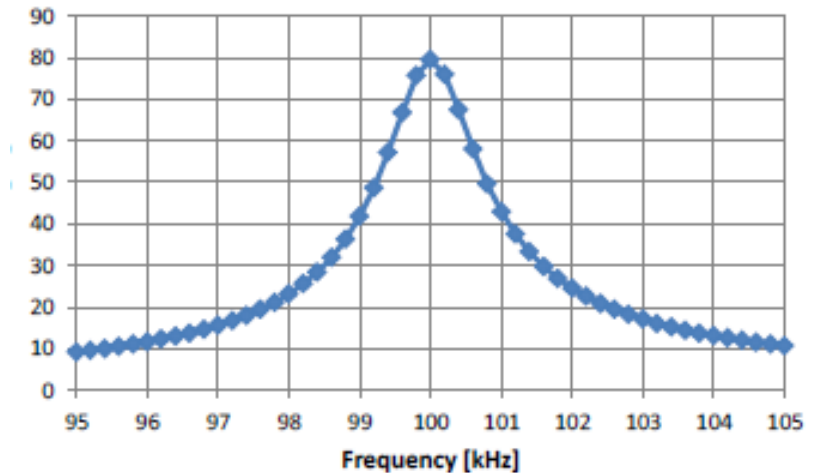
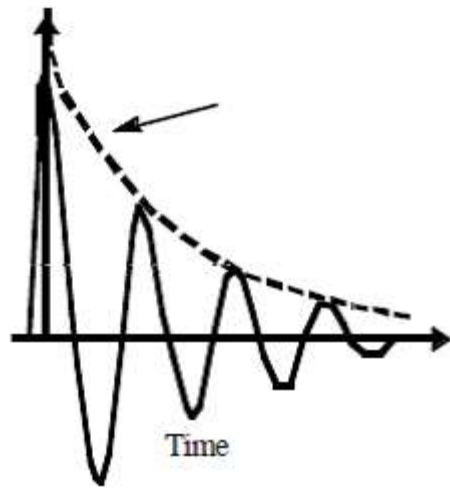
# Digital ping and Multiple Digital Ping

- Is used for WCH Receiver detection
- It consumes big amount of energy
- The receiver is waked up and communicate with the Transmitter over ASK modulation
- When a small Signal strength packed or no RX response is being received, the Multiple Digital Ping is started with ramping up process with the amount of energy for the Digital ping



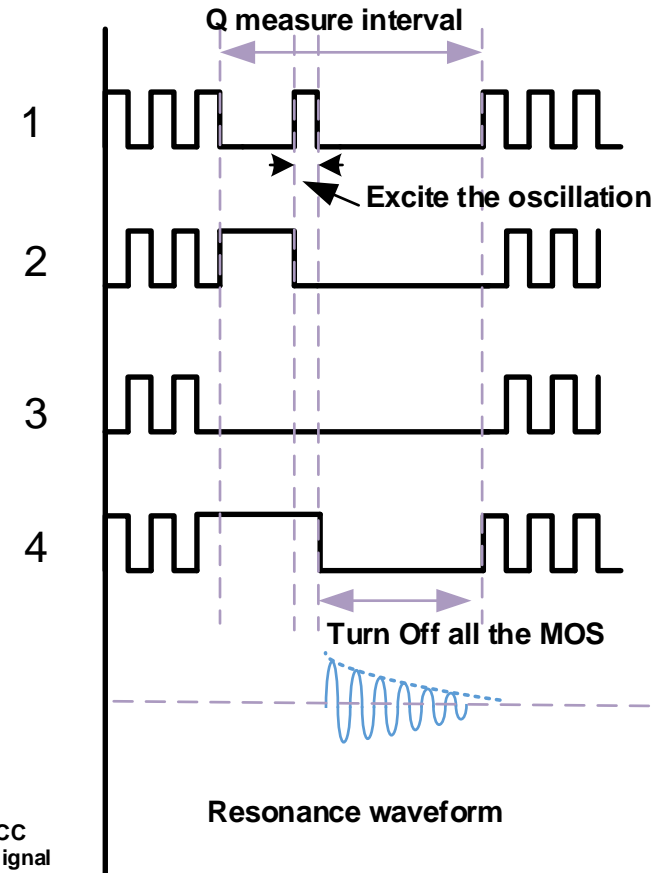
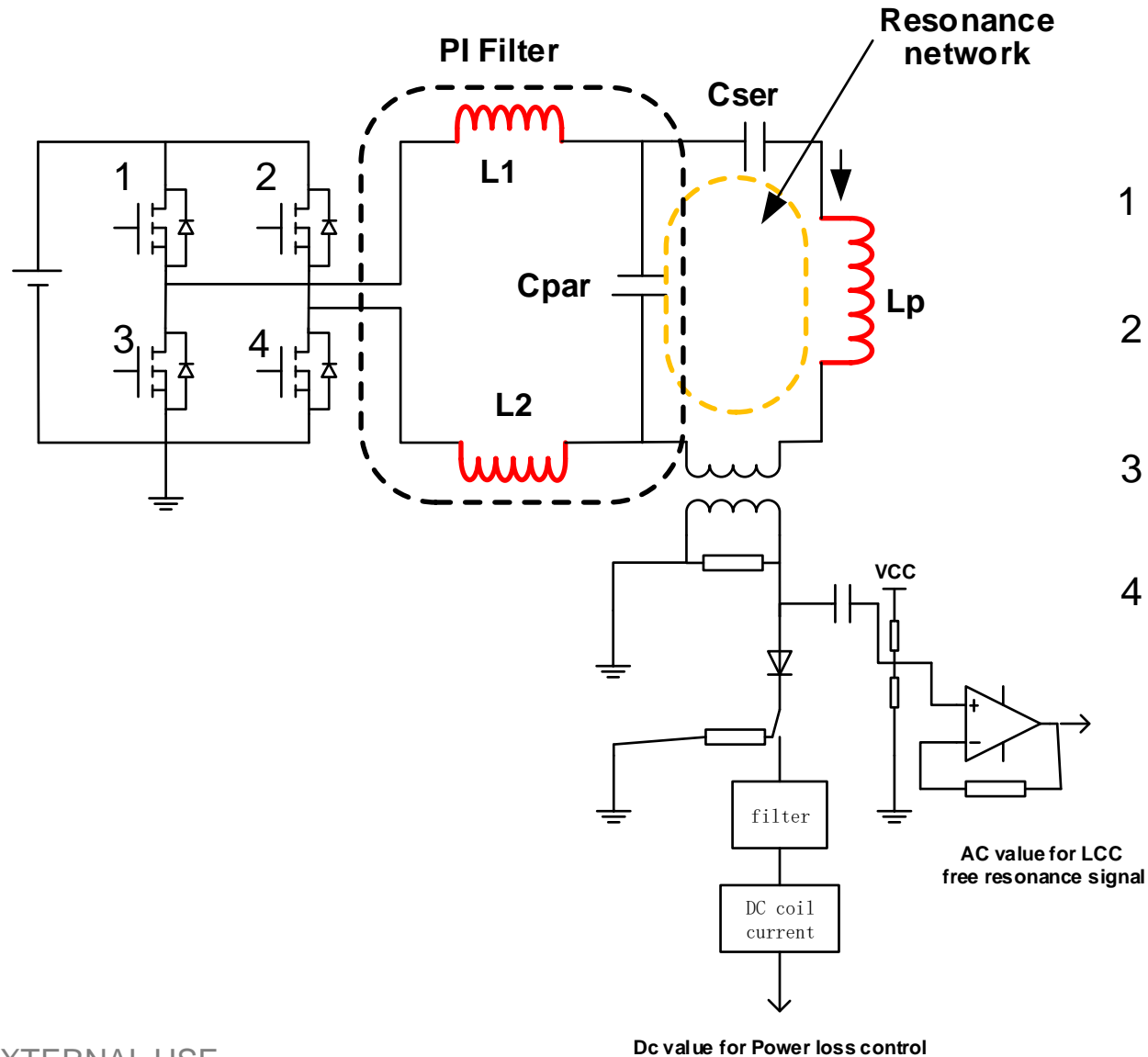
# Q factor sensing

- The Free resonance method is used for the  $Q_{LC}$  calculation, where the measurement is done via:  
 $Q_{LC} = \pi / (-\ln(\text{Rate}))$ , decay of the amplitude peaks of the resonance signal
  - one excitation signal is required for the Free resonance frequency measurement and the second for the peak values measuring.





# Q factor sensing – HW configuration



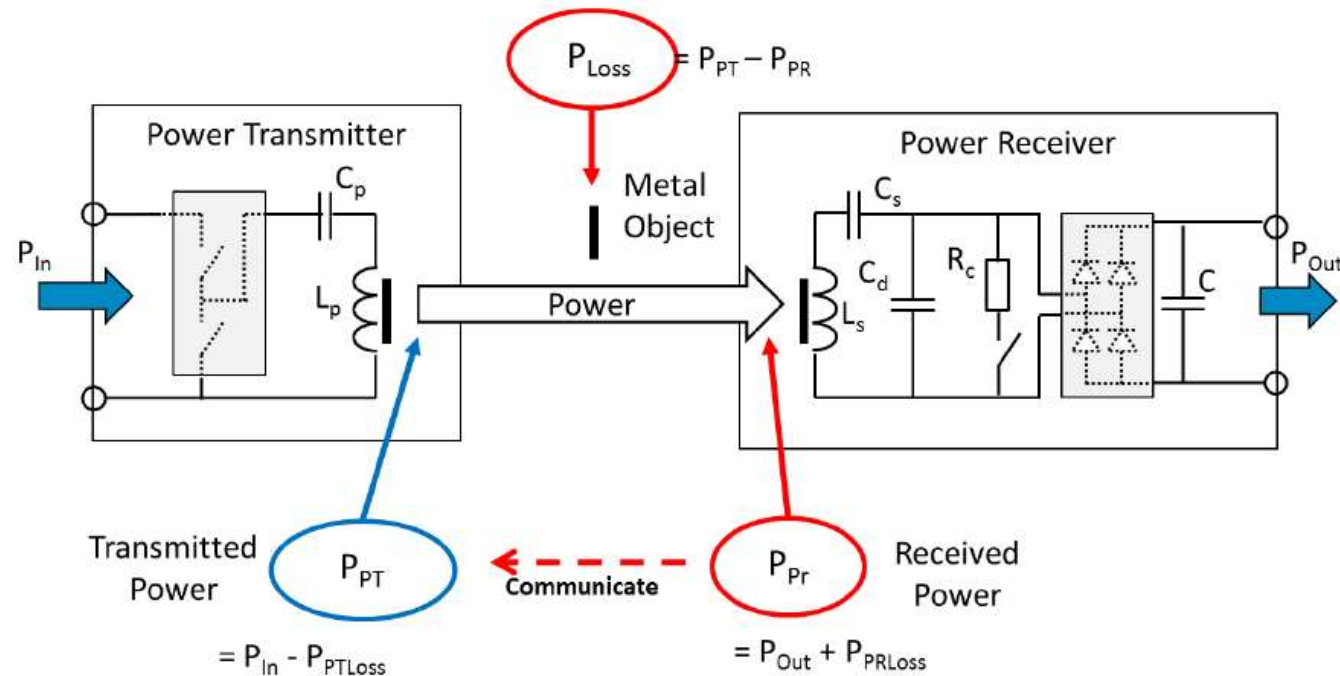
# Foreign Object Detection Method

The methods is used for the FO detection placed on the WCH transmitter. It is a prevention of the FO overheating and any damage prevention.

- Pre charging FOD method (Based on the Q factor sensing)
- During Charging FOD method
- Power Loss Control (PLC) method

# During Charging FOD method

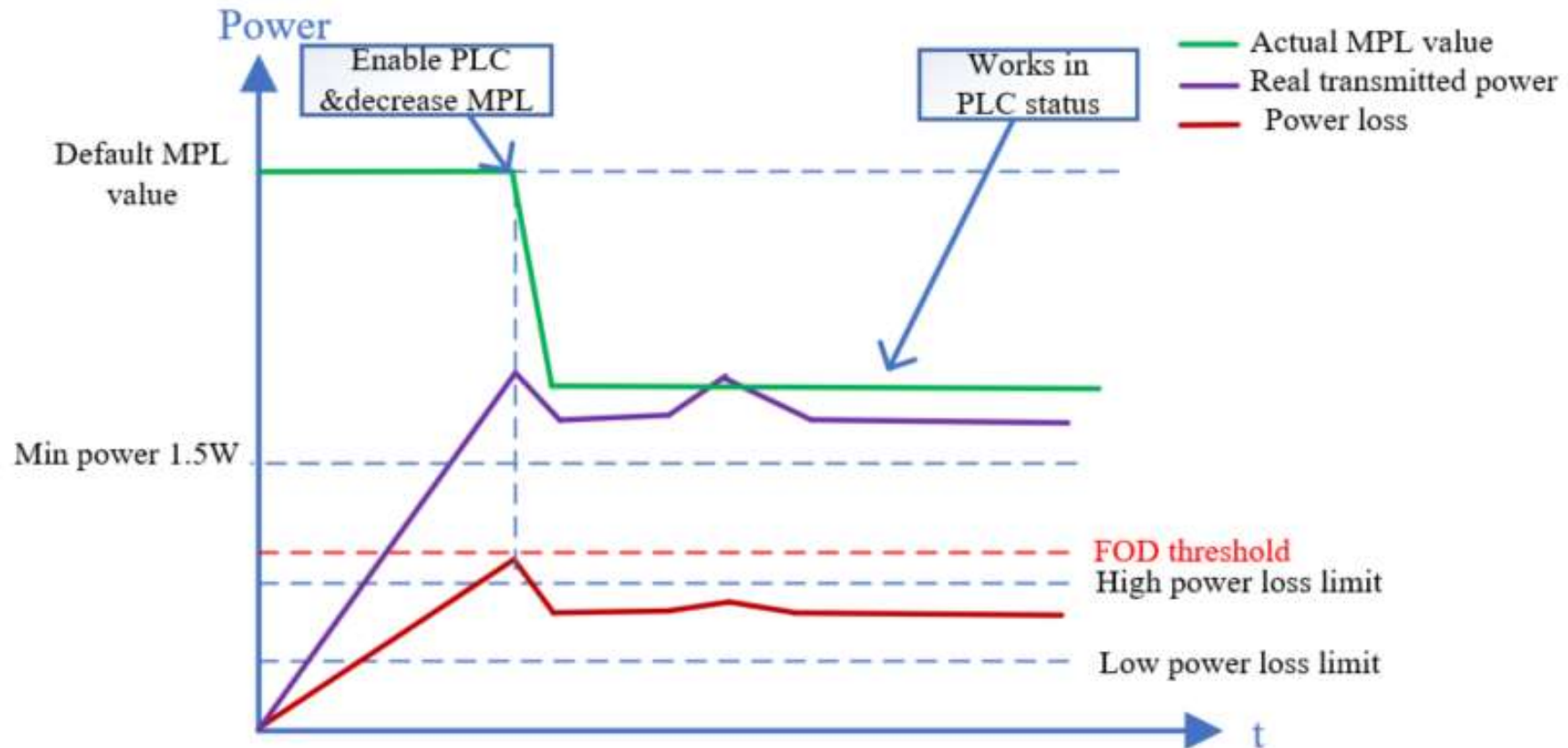
- FOD is based on the calibrated power loss accounting
- Calibration is performed without FO and during the charging the model is calculating the internal losses and compares it with amount of energy delivered to the WCH Receiver. When the FO is placed on the Transmitter, the energy is being loosed there and the calculation will not fit.



# Power Loss Control (PLC) method

The method is based on the regulation of the maximal delivered energy to the WCH receiver so the FO placed on the WCH transmitter will not be overheated.

Working case:

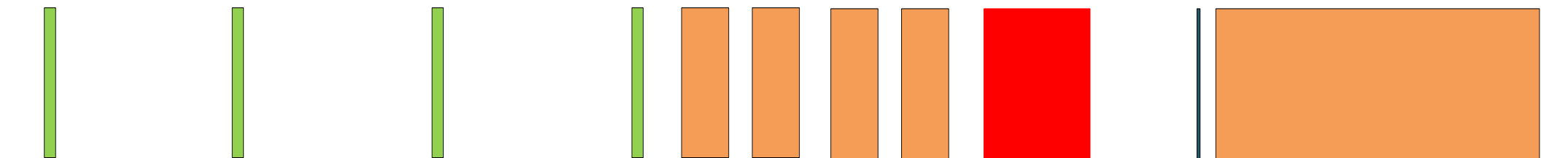


# NFC detection and protection

One of the most critical part of the WCH technology is the NFC card/tags detection. The NFC object shall be destroyed by the Wireless Transmitter power.

The NFC sensing circuit is used to detect all NFC objects.

Standard NFC workflow (based on the Qi 1.3.3):



Analog ping



NFC detection

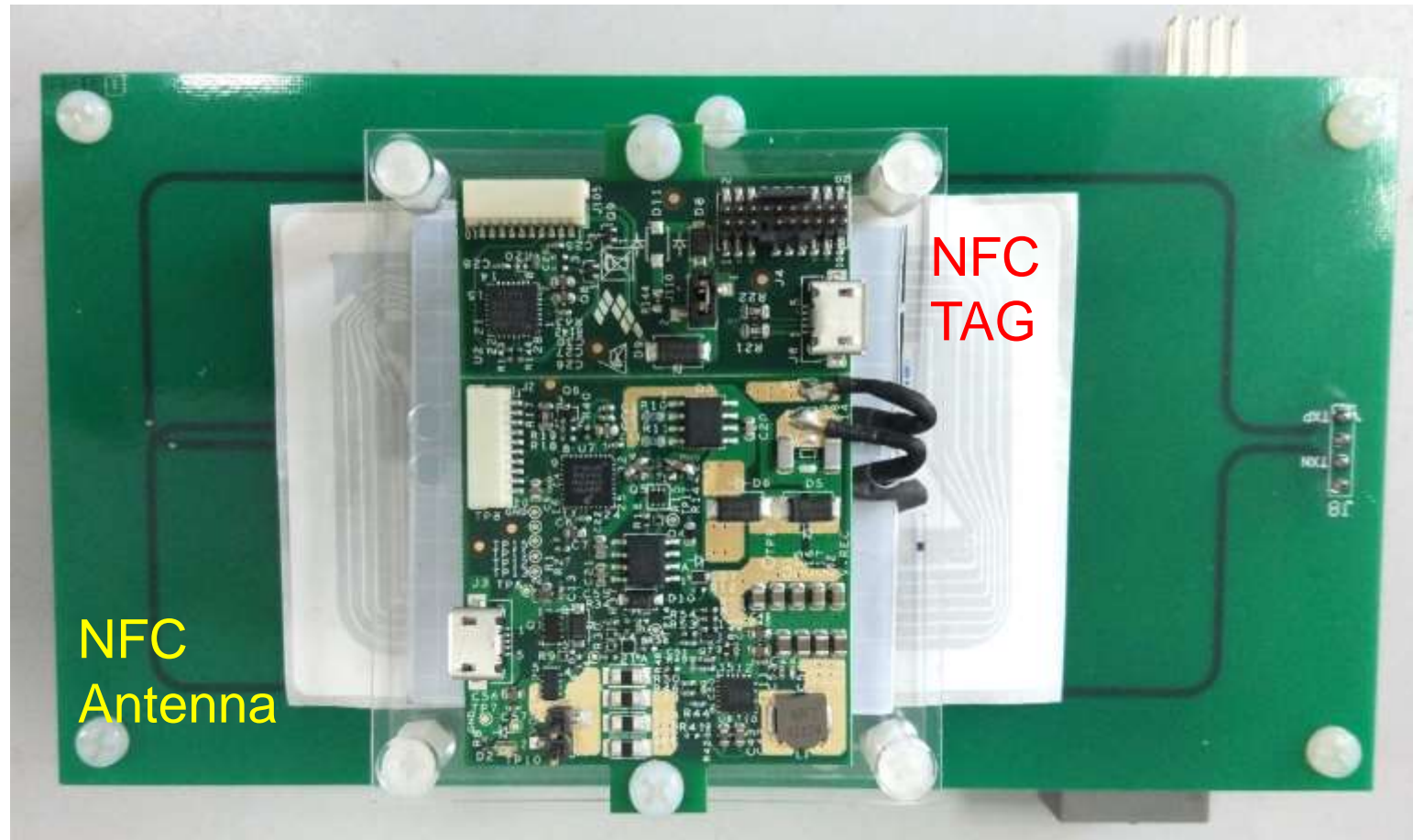


Q measurement



Digital ping

# NFC card detection example

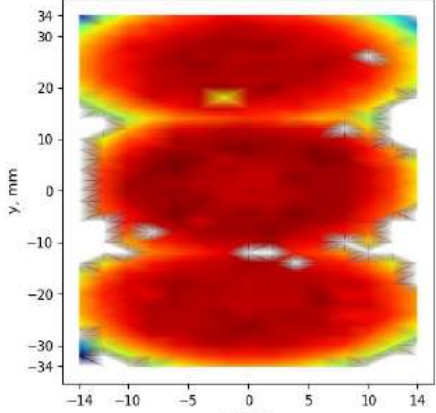


# Wireless Charging Testing

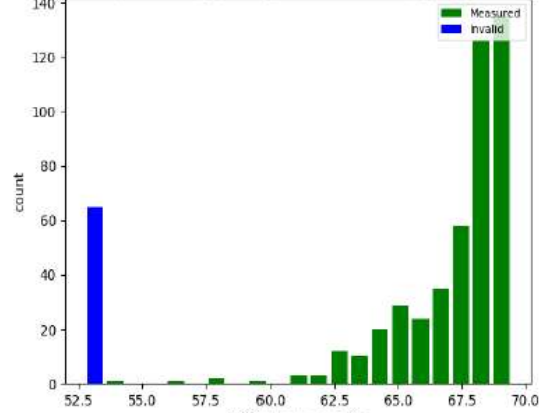
- Testing is processed according to the Wireless charging standard (Qi 1.3.3).
- A special testing tools are used for all aspects of the standard and checked on the certified laboratories.
- NXP provides Qi pre-testing on equivalent test tools and our internal Test tool (Automated Test Bench).
- Interoperability is processed during the Qi certification, so the cross cooperation is granted.
- Efficiency and the Transmitter charging ability coverage map is being performed.

# Wireless Charging Testing

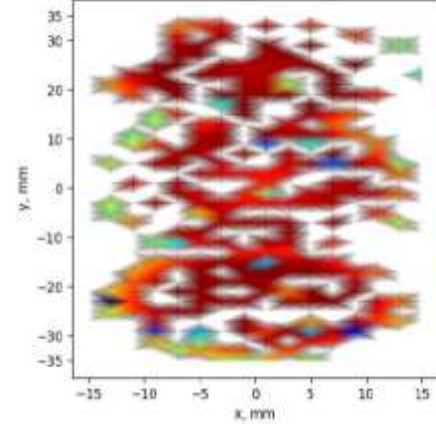
Eff\_system\_peak at z = 4.5, p\_out\_typ = 5



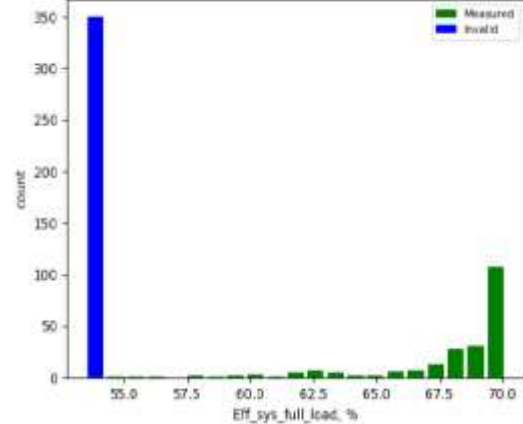
Histogram of Eff\_system\_peak at z = 4.5, p\_out\_typ = 5



Eff\_sys\_full\_load at p\_out = 15



Histogram of Eff\_sys\_full\_load at p\_out = 15







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