Remote Implementation Example
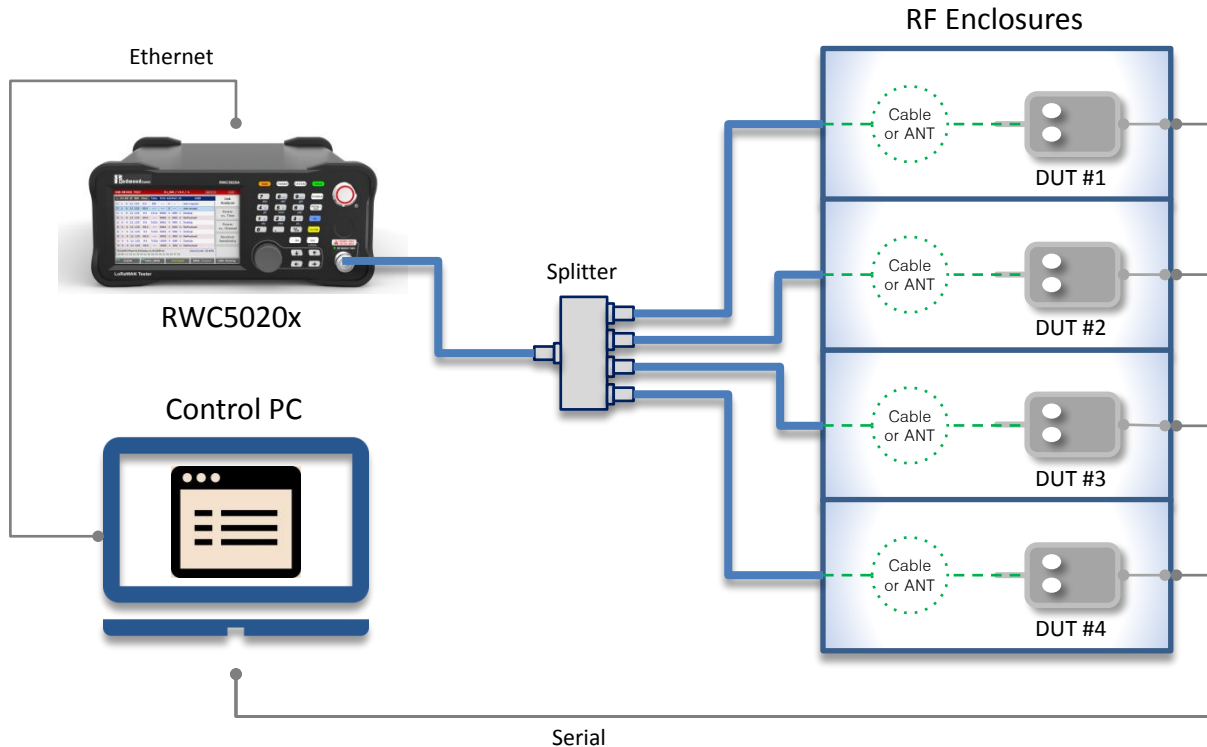## for RWC5020x FW V1.325 or higher

For Testing in Production Lines: *4 DUTs per Tester*

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Test Setup Example for Production Lines

RF Enclosures

Ethernet

RWC5020x

Control PC

Splitter

Cable or ANT — DUT #1

Cable or ANT — DUT #2

Cable or ANT — DUT #3

Cable or ANT — DUT #4

Serial

[RX TEST]
- *The test packets sent by the tester as specified are transferred to each DUT by a splitter at the same time.*
- *Each DUT counts the number of packets it receives, which is read by the user application software.*

[TX TEST]
- *A DUT is forced to transmit CW signal.*
- *The tester measures the power and the frequency* of the CW signal.*
- *A DUT is forced to send the LoRa test packets.*
- *The tester measures the power of the test packets.*
- *The rest of DUTs are tested in turns.*

- *The tester shall be controlled by the user application software via Ethernet.*
- *This software may also control the DUTs if necessary.*

- *The DUTs should be put into RF enclosure(s) to minimize the effect of interferences.*
- *Any available or efficient method can be adopted for RF connection; either radiated or conducted.*

** Frequency measurement is available only in **RWC5020B/M**.*

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Initialization

CONFIGURATION - GENERAL

CONFIGURATION for TEST PARAMETERS

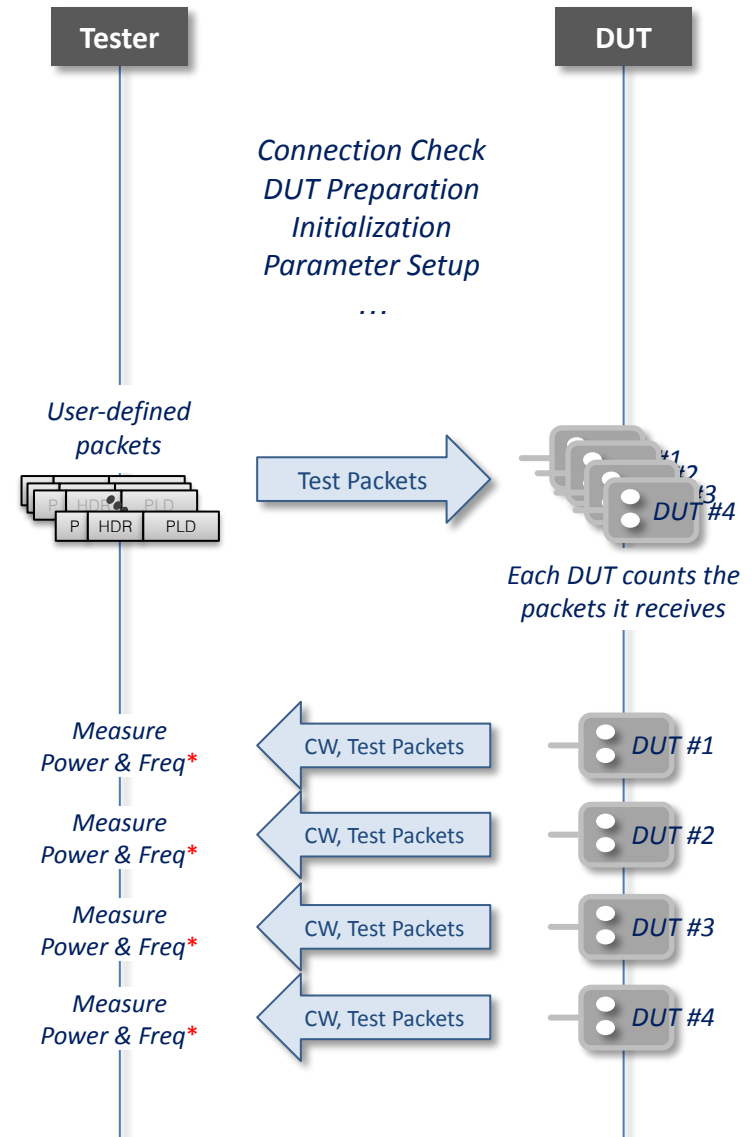PREPARATION of DUTs

RX Test

RECEIVER SENSITIVITY MEASUREMENT

TX Test

CW POWER & FREQUENCY* MEASUREMENT

LoRa PACKET POWER MEASUREMENT

You may select a way to test TX performance of devices; CW only, LoRa packet only, or both.

Tester

DUT

*Connection Check
DUT Preparation
Initialization
Parameter Setup*

...

User-defined packets

| P | HDR | PLD |

Test Packets →

DUT #1
DUT #2
DUT #3
DUT #4

Each DUT counts the packets it receives

Measure Power & Freq* ← CW, Test Packets — DUT #1

Measure Power & Freq* ← CW, Test Packets — DUT #2

Measure Power & Freq* ← CW, Test Packets — DUT #3

Measure Power & Freq* ← CW, Test Packets — DUT #4

** Frequency measurement is available only in **RWC5020B/M**.*

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```
START
```

CONFIGURATION - GENERAL

Please be sure that the Ethernet setup with IP configuration has been completed prior to starting this example. You may refer to the User Manual or Application Note of RWC5020x for further information.

Check Ethernet Connection

```
*IDN?
READ:SYSTEM:SERIAL_NUM?
```

Check the connection to the tester via Ethernet.

Check SW Version

```
READ:SYSTEM:SW_VERSION?
```

Optional

CONFIGURATION for TEST PARAMETERS

Set RX Test Parameters

```
CONF:NST:TX:MODULATION LORA
CONF:NST:TX:NETWORK PRIVATE
CONF:NST:TX:CR 4_5
CONF:NST:TX:SF SF7
CONF:NST:TX:BW 125
CONF:NST:TX:TX_POLARITY NORMAL
CONF:NST:TX:PREAMBLE_SIZE 8
CONF:NST:TX:PAYLOAD_SIZE 16
CONF:NST:TX:PAYLOAD 0x00010203...0E0F
CONF:NST:TX:INTERVAL 0.1
CONF:NST:TX:REPEAT_NUM 10
```

Set the parameters required for RX Test of DUTs.
- INTERVAL defines the time delay between two consecutive TX packets
- Set the REPEAT_NUM properly for efficiency.

Set TX Test Parameters

```
CONF:NST:RX:MODULATION LORA
CONF:NST:RX:NETWORK PRIVATE
CONF:NST:RX:CR CRC
CONF:NST:RX:SF SF7
CONF:NST:RX:BW 125
CONF:NST:RX:RX_POLARITY NORMAL
CONF:NST:RX:FCNT_AVG_N 1
```

Set the parameters required for TX Test of DUTs.
- SF can be set to ANY, in which case the tester can receive packets of any SF, provided that BW is fixed to 125kHz.
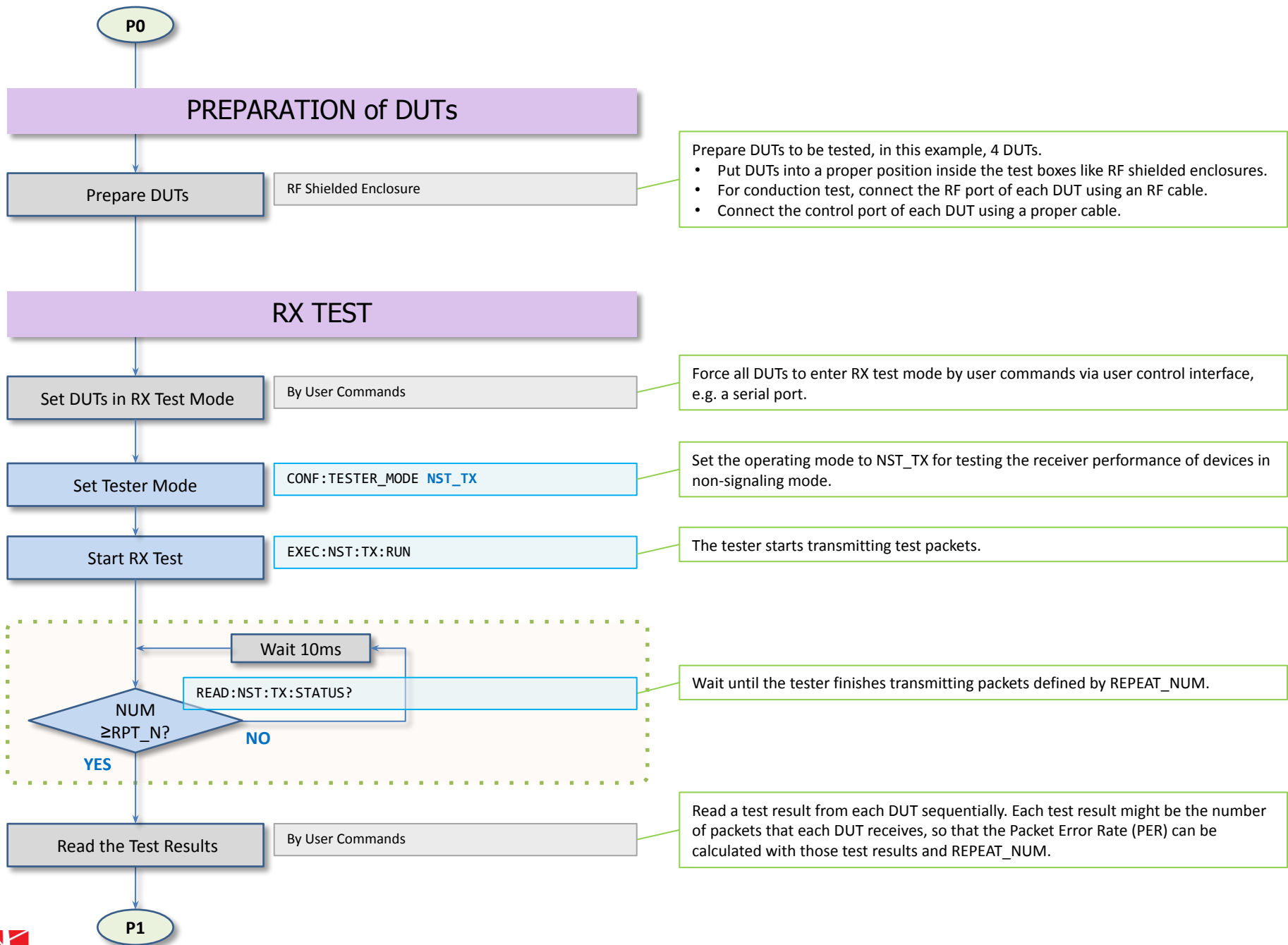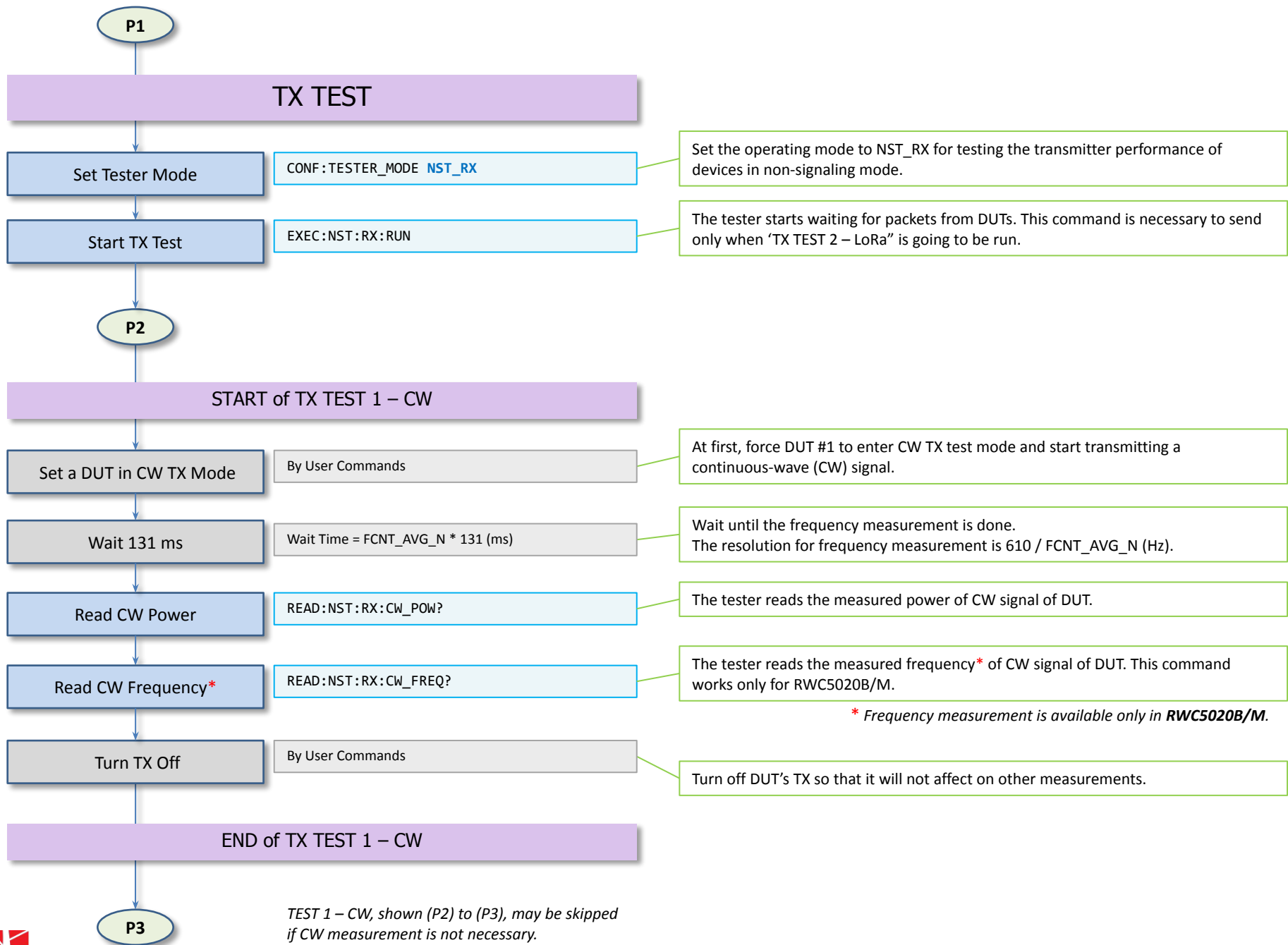
Set RF Parameters

```
CONF:RF:FREQ 868.0
CONF:RF:TX_POW -123
CONF:RF:PATH_LOSS 20
CONF:RF:RX_AGC OFF
CONF:RF:RX_GAIN LOW
```

Set the RF parameters. Any parameter can be changed according to users' test purpose.
- Turn off the Automatic Gain Control (AGC) function of the tester and set the RX_GAIN properly according to the DUT power.

```
P0
```

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P0

PREPARATION of DUTs

Prepare DUTs	RF Shielded Enclosure

Prepare DUTs to be tested, in this example, 4 DUTs.
- Put DUTs into a proper position inside the test boxes like RF shielded enclosures.
- For conduction test, connect the RF port of each DUT using an RF cable.
- Connect the control port of each DUT using a proper cable.

RX TEST

Set DUTs in RX Test Mode	By User Commands

Force all DUTs to enter RX test mode by user commands via user control interface, e.g. a serial port.

Set Tester Mode	`CONF:TESTER_MODE NST_TX`

Set the operating mode to NST_TX for testing the receiver performance of devices in non-signaling mode.

Start RX Test	`EXEC:NST:TX:RUN`

The tester starts transmitting test packets.

Wait 10ms

`READ:NST:TX:STATUS?`

NUM ≥RPT_N?

NO

YES

Wait until the tester finishes transmitting packets defined by REPEAT_NUM.

Read the Test Results	By User Commands

Read a test result from each DUT sequentially. Each test result might be the number of packets that each DUT receives, so that the Packet Error Rate (PER) can be calculated with those test results and REPEAT_NUM.

P1

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P1

TX TEST

Set Tester Mode	`CONF:TESTER_MODE NST_RX`

Set the operating mode to NST_RX for testing the transmitter performance of devices in non-signaling mode.

Start TX Test	`EXEC:NST:RX:RUN`

The tester starts waiting for packets from DUTs. This command is necessary to send only when 'TX TEST 2 – LoRa" is going to be run.

P2

START of TX TEST 1 – CW

Set a DUT in CW TX Mode	By User Commands

At first, force DUT #1 to enter CW TX test mode and start transmitting a continuous-wave (CW) signal.

Wait 131 ms	Wait Time = FCNT_AVG_N * 131 (ms)

Wait until the frequency measurement is done.
The resolution for frequency measurement is 610 / FCNT_AVG_N (Hz).

Read CW Power	`READ:NST:RX:CW_POW?`

The tester reads the measured power of CW signal of DUT.

Read CW Frequency*	`READ:NST:RX:CW_FREQ?`

The tester reads the measured frequency* of CW signal of DUT. This command works only for RWC5020B/M.

** Frequency measurement is available only in **RWC5020B/M**.*

Turn TX Off	By User Commands

Turn off DUT's TX so that it will not affect on other measurements.

END of TX TEST 1 – CW

P3

TEST 1 – CW, shown (P2) to (P3), may be skipped if CW measurement is not necessary.

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P3

START of TX TEST 2 – LoRa

| Clear the Old Results | `EXEC:NST:RX:CLEAR` | The tester clears all history of old measurement results. |

| Set a DUT in LoRa TX Mode | By User Commands | At first, force DUT #1 to enter TX test mode and start the LoRa test packets as many as defined. |

Wait until DUT finishes transmission

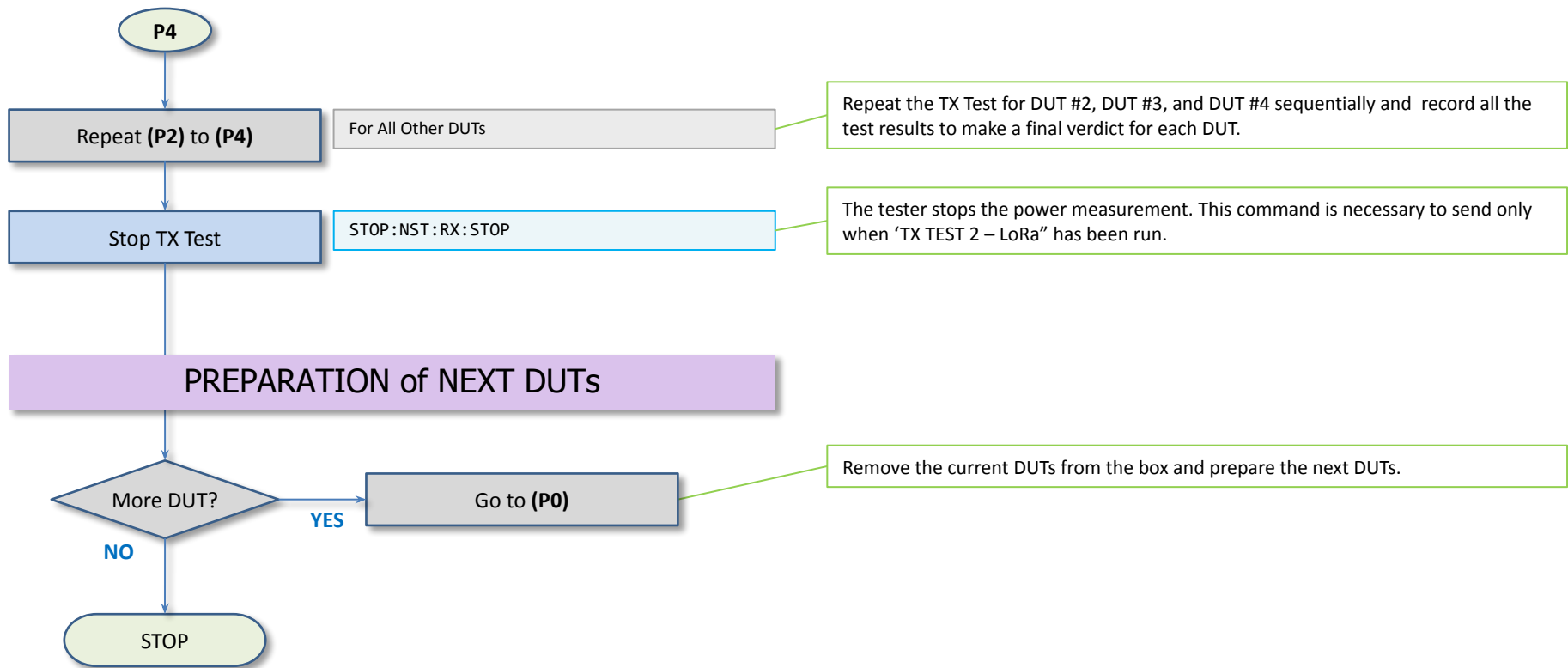| Turn Off TX | By User Commands | Turn off DUT's TX so that it will not affect on other measurements. |

| Read Test Results | `READ:NST:RX:POW_AVG?`
`READ:NST:RX:POW_MIN?`
`READ:NST:RX:POW_MAX?` | Read the result values for the current DUT. |

END of TX TEST 2 – LoRa

TEST 2 – LoRa, shown (P3) to (P4), may be skipped if LoRa measurement is not necessary.

P4

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P4

Repeat **(P2)** to **(P4)** | For All Other DUTs

Repeat the TX Test for DUT #2, DUT #3, and DUT #4 sequentially and record all the test results to make a final verdict for each DUT.

Stop TX Test | `STOP:NST:RX:STOP`

The tester stops the power measurement. This command is necessary to send only when 'TX TEST 2 – LoRa' has been run.

PREPARATION of NEXT DUTs

More DUT?

YES → Go to **(P0)**

Remove the current DUTs from the box and prepare the next DUTs.

NO

STOP

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Test Time Estimation

RX TEST

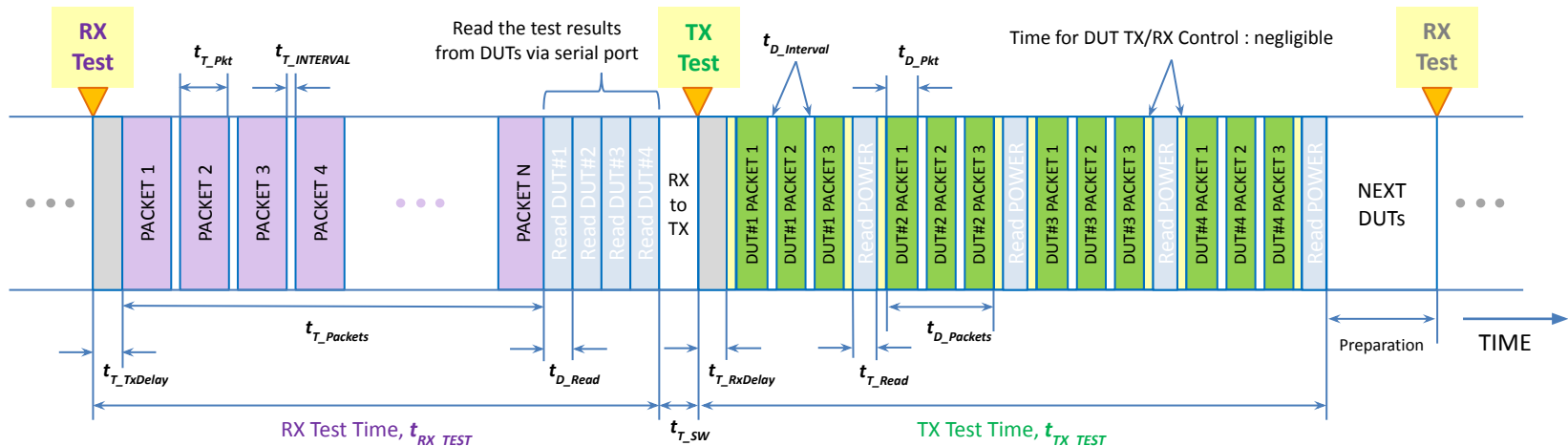**Key Factors in RWC5020x**
- Packet
  - SF   SF7-SF12
  - PREAMBLE_SIZE   2-12 symbols
  - PAYLOAD_SIZE   0-250 bytes
- REPEAT_NUM   1-10000
- INTERVAL   0.01-1000 sec

TX TEST

Key Factors in DUT
- Packet
  - SF   user-defined
  - Preamble size   user-defined
  - Payload size   user-defined
- Number of packets   user-defined
- Interval   user-defined

RX Test

t_{T_Pkt} $t_{T\_INTERVAL}$

Read the test results from DUTs via serial port

TX Test

$t_{D\_Interval}$ t_{D_Pkt} Time for DUT TX/RX Control : negligible

RX Test

PACKET 1 PACKET 2 PACKET 3 PACKET 4 ... PACKET N Read DUT#1 Read DUT#2 Read DUT#3 Read DUT#4 RX to TX DUT#1 PACKET 1 DUT#1 PACKET 2 DUT#1 PACKET 3 Read POWER DUT#2 PACKET 1 DUT#2 PACKET 2 DUT#2 PACKET 3 Read POWER DUT#3 PACKET 1 DUT#3 PACKET 2 DUT#3 PACKET 3 Read POWER DUT#4 PACKET 1 DUT#4 PACKET 2 DUT#4 PACKET 3 Read POWER NEXT DUTs ...

$t_{T\_Packets}$ $t_{D\_Packets}$ Preparation   TIME

$t_{T\_TxDelay}$ t_{D_Read} $t_{T\_RxDelay}$ t_{T_Read}

RX Test Time, t_{RX_TEST}

t_{T_SW} (≈100ms)

TX Test Time, t_{TX_TEST}

$$t_{RX\_TEST} = t_{T\_TxDelay} + t_{T\_Packets} + t_{D\_Read} \times N_{DUT}$$

- $t_{T\_TxDelay}$: about 150ms
- t_{D_Read} : depends on DUT (assume 200ms)
- $t_{T\_Packets} = t_{T\_Pkt} \times N_{REPEAT} + t_{T\_INTERVAL} \times (N_{REPEAT}-1)$

[Example]

SF7, PAYLOAD_SIZE=16, REPEAT_NUM=10, INTERVAL=10ms
- $t_{T\_Packets} \approx 51 \times 10 + 10 \times 9 = 600$ms
- $t_{RX\_TEST} \approx 150 + 600 + 200 \times N_{DUT}$
  - $t_{RX\_TEST} \approx 950\text{-}1000$ms for $N_{DUT}=1$
  - $t_{RX\_TEST} \approx 1500\text{-}1600$ms for $N_{DUT}=4$

$$t_{TX\_TEST} = t_{T\_RxDelay} + (t_{D\_Packets} + t_{T\_Read}) \times N_{DUT}$$

- $t_{T\_RxDelay}$: about 150ms
- t_{T_Read} : about 200ms
- $t_{D\_Packets} = t_{D\_Pkt} \times N_{Packet} + t_{D\_Interval} \times (N_{Packet}-1)$

[Example]

SF7, Payload size=16, Number of packets=3, Interval=10ms
- $t_{D\_Packets} \approx 51 \times 3 + 10 \times 2 = 173$ms
- $t_{TX\_TEST} \approx 150 + (173 + 200) \times N_{DUT}$
  - $t_{TX\_TEST} \approx 500\text{-}550$ms for $N_{DUT}=1$
  - $t_{TX\_TEST} \approx 1500\text{-}1650$ms for $N_{DUT}=4$

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