
# A7102A Firmware Introduction

# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.ADC function
8.RTC function

# FW topic (Con.)

## Appendix A : RF reference code

## Appendix B : Develop tools

**RF module, EV board, DV board , MP board**

# RF feature

- Frequency bands: 315MHz/433MHz, 868MHz/915MHz @ FSK,GFSK
- Programmable RF TX output power: up to 15dBm@35mA
- Data rate up to 150Kpbs@sensitivity : -104dBm, RX :12.5mA

  (Data rate up to 50Kpbs@sensitivity : -110dBm)
- Build in RSSI, temperature sensor function
- Build in RTC, 1ch external ADC function
- Supply voltage 2.2 ~ 3.6V
- 64 bytes TX/RX FIFO buffer
- Build in FIFO extension function with up to 256 bytes FIFO No
- Optional Manchester Data / FEC / CRC / data whitening (encryption)
- It is applicable with long distance remote control(1~2KM).
- Oscillator clock out / External clock in

# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.RF channel hopping
8.RTC function

# Wireless system

One way RF link

# Wireless system

One way RF link


Command or data

# Wireless system

One way RF link


Two way RF link

# Wireless system

One way RF link


Command or data

Two way RF link

ACK


Command or data

# Wireless system

One way RF link


Command or data

Two way RF link

ACK


Command or data

# Wireless system

One way RF link


Command or data

Two way RF link

ACK


Command or data

Data rate : low => security system
Data rate : high => voice

# Wireless system

**Consist of**

- Base band

# Wireless system

**Consist of**

- Base band
- RF

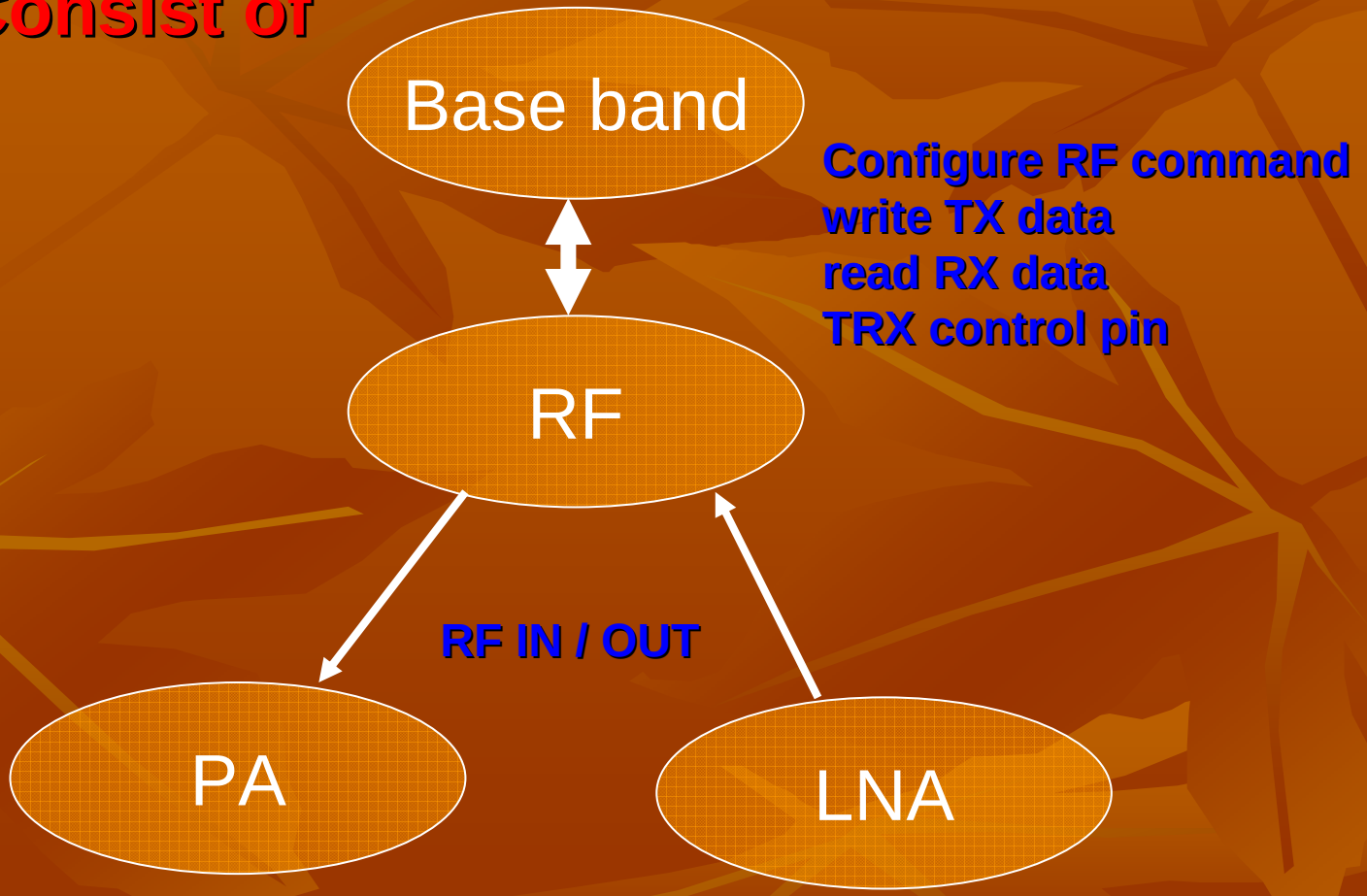
# Wireless system

**Consist of**

- Base band
- RF
- PA
- LNA

# Wireless system

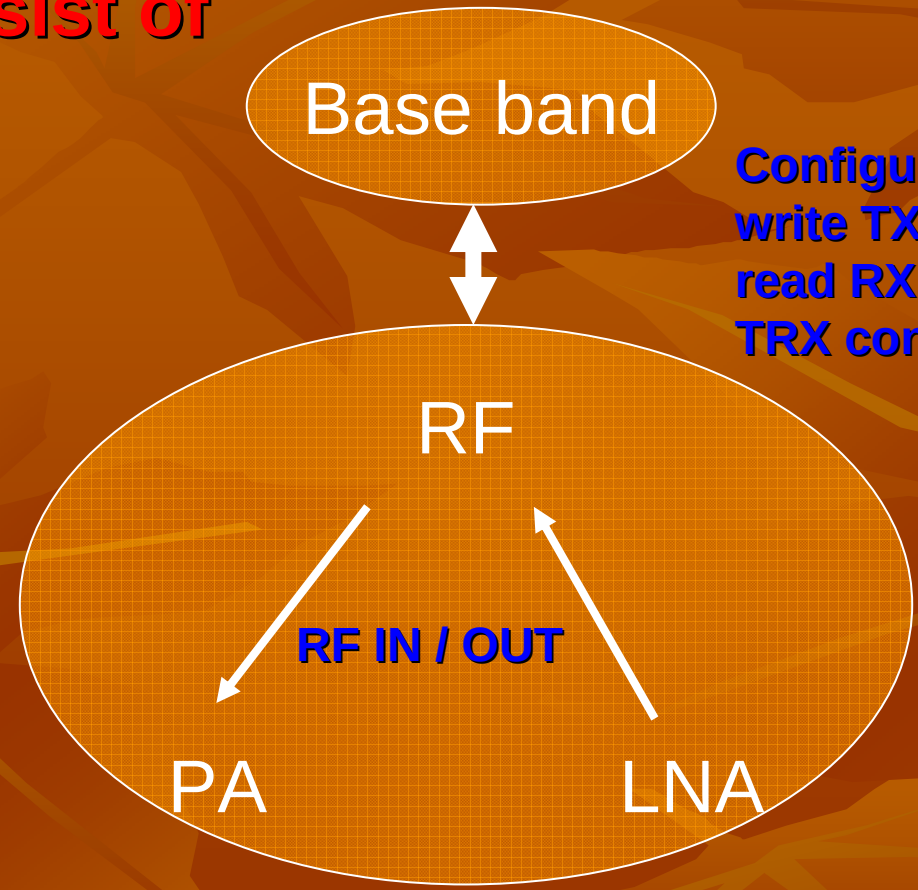
**Consist of**




**Configure RF command**
**write TX data**
**read RX data**
**TRX control pin**

# Wireless system

**Consist of**




**Configure RF command**
**write TX data**
**read RX data**
**TRX control pin**

**Build in PA with 15dBm power**

# Wireless system

## Base band requirement

1.GP I/O No.
2.GP I/O driving voltage : 2.2V~3.3V
3.Power consumption
4.Computing power
5.Cost
6.serial interface for RF command or data

# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.ADC function
8.RTC function

# Wireless system operation

**TX side**

Initial

**1.Initial MCU**
**2.initial RF**

# Wireless system operation

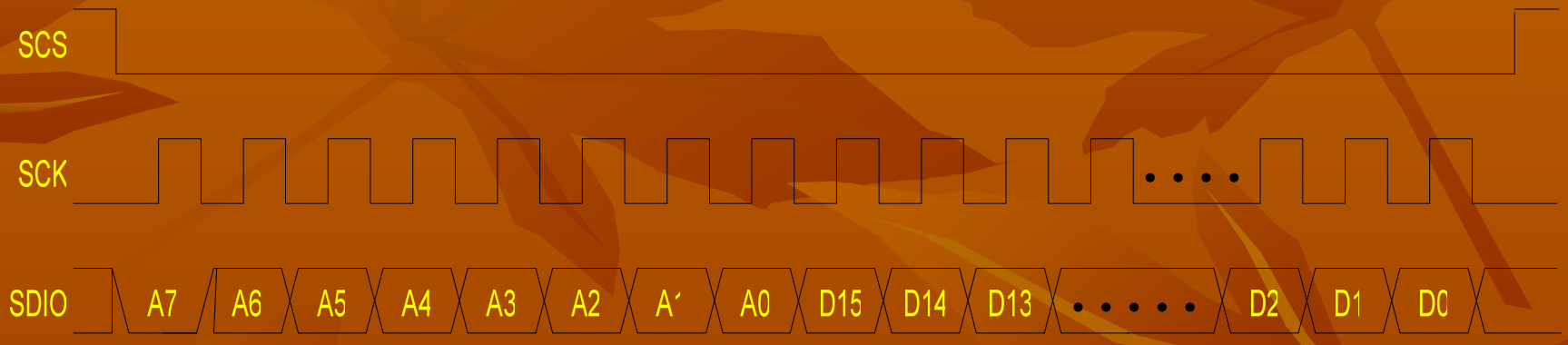
**TX side**

Initial

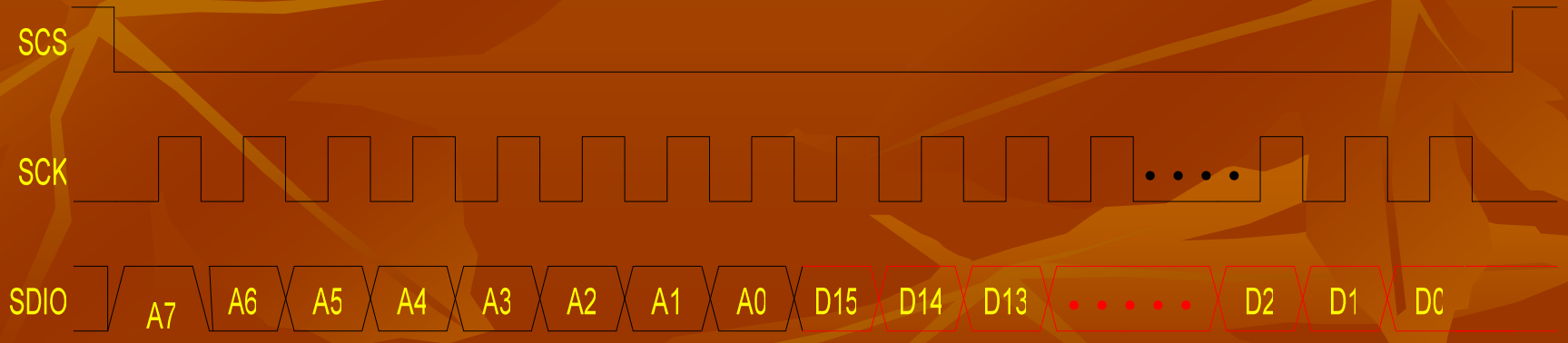
**1.Reset RF**
**2.initial RF configuration**
**3.calirbation — IF, VCO, RSSI, TEMP**

# Wireless system operation

## SPI Timing Chart：Latch data at rising edge of SCK pin



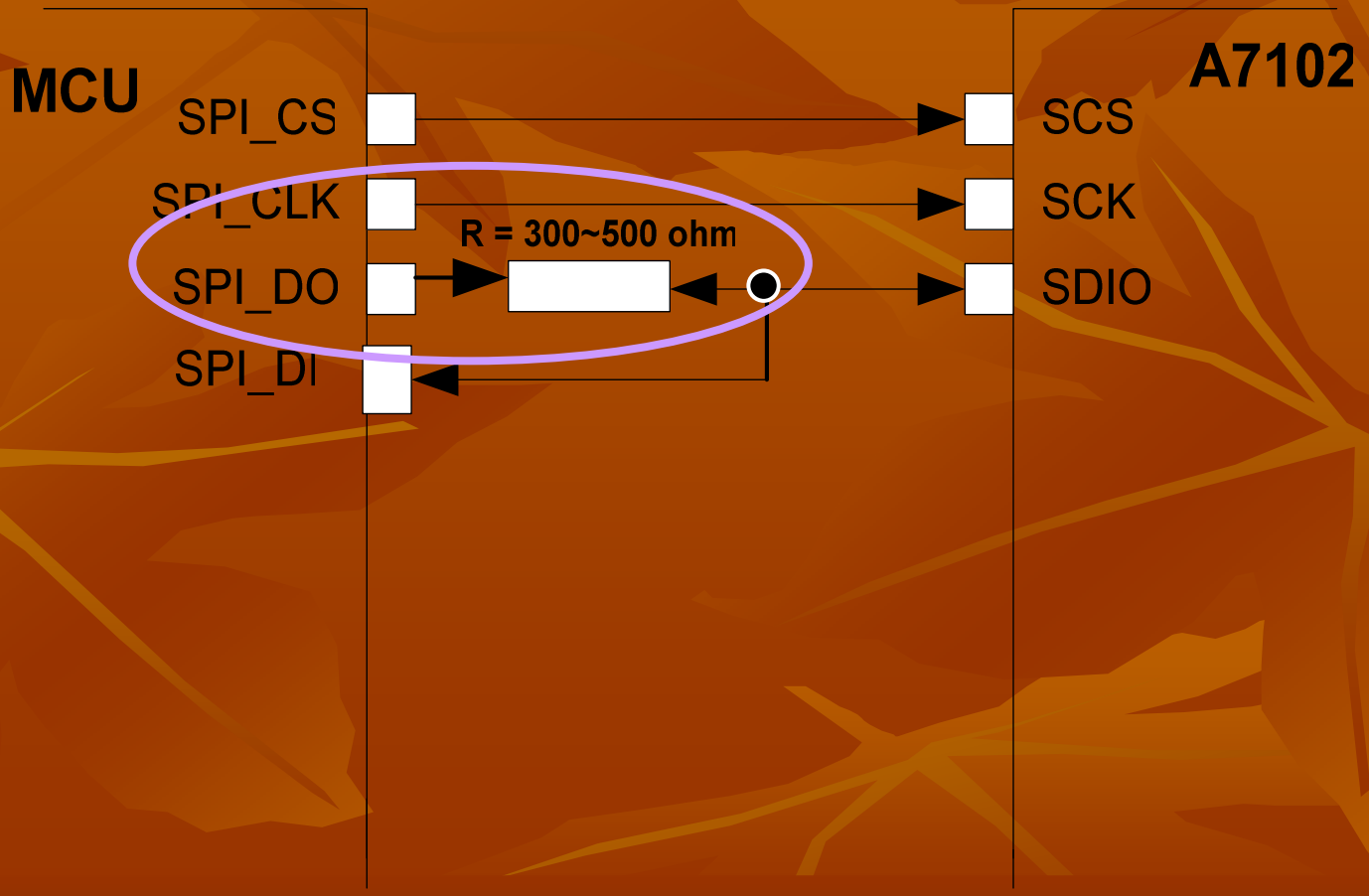

SPI write operation




SPI read operation

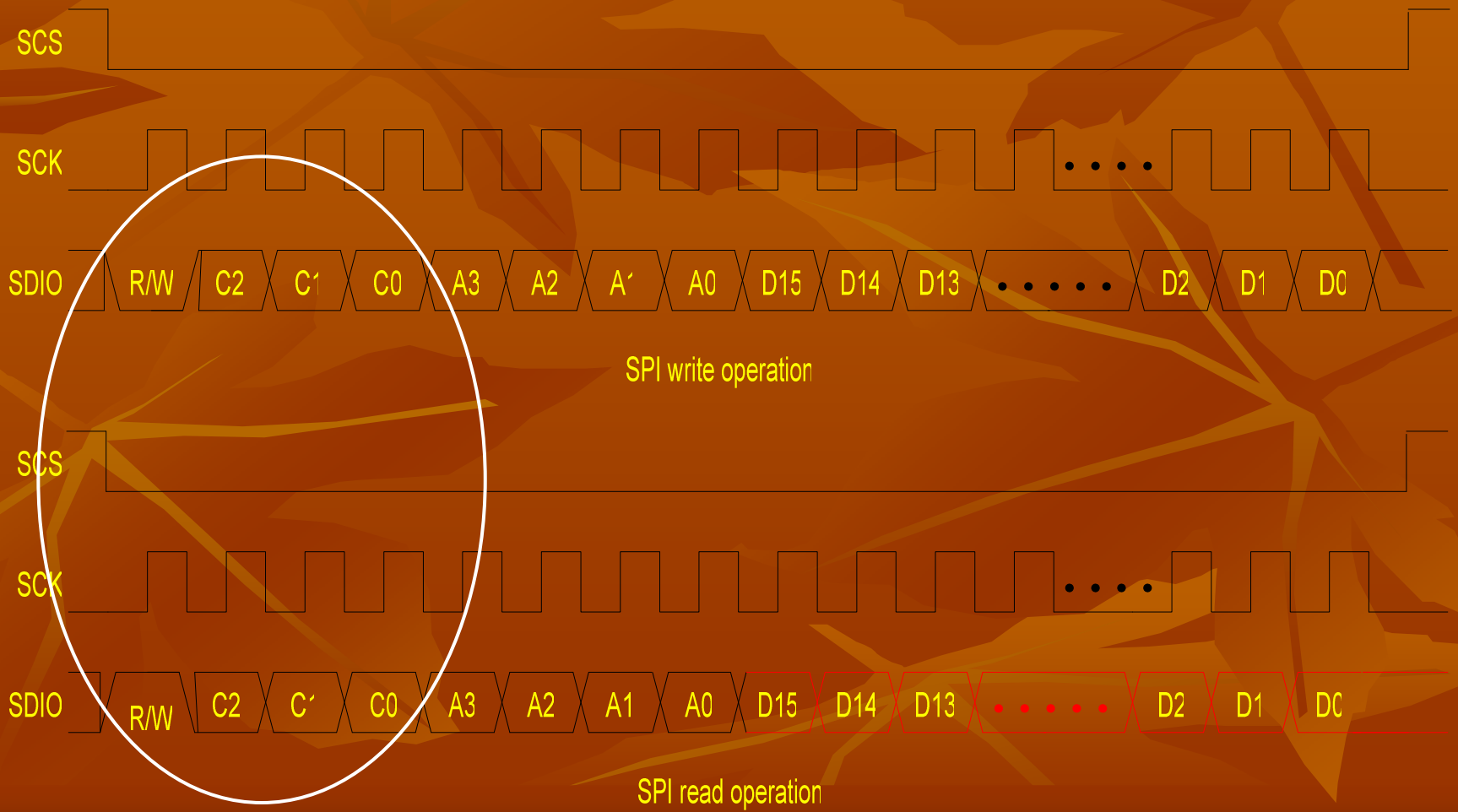
# Wireless system operation

## How to connect the standard SPI interface?



# Wireless system operation

## SPI Timing Chart：Latch data at rising edge of SCK pin

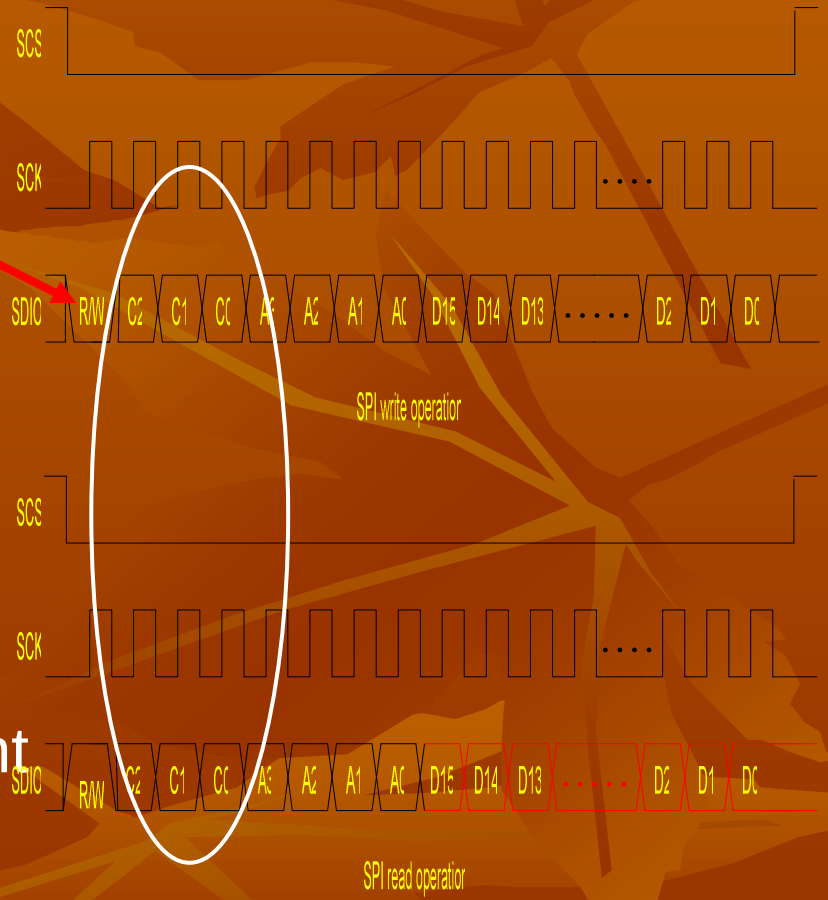


# Wireless system operation

## SPI Command

**Bit 7: R/W bit**
[0]: write command data
[1]: Read command data

**Bit [6:4]: Command**
[00X]: R / W control register
[01X]: R / W ID code
[10X]: R / W FIFO register
[110]: Reset TX/RX FIFO point
[111]: Reset RF register



# Wireless system operation

## SPI Command

**Bit 7: R/W bit**
[0]: write command data / TX
[1]: Read command data / RX

**Bit [6:4]: Command**
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# Wireless system operation

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# Wireless system operation

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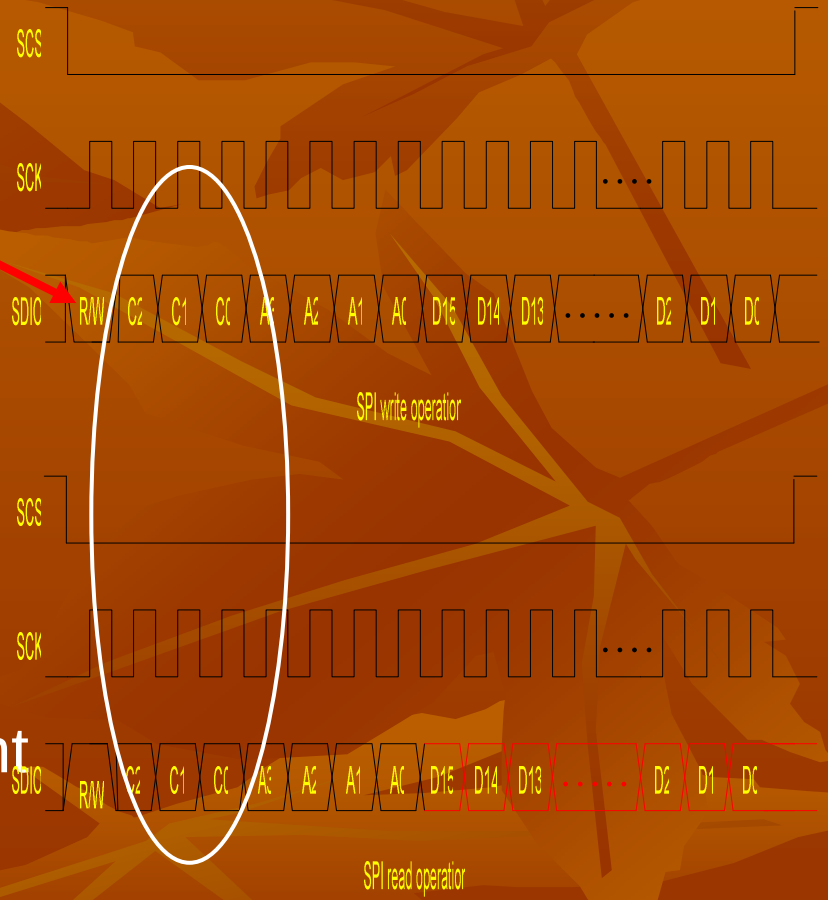
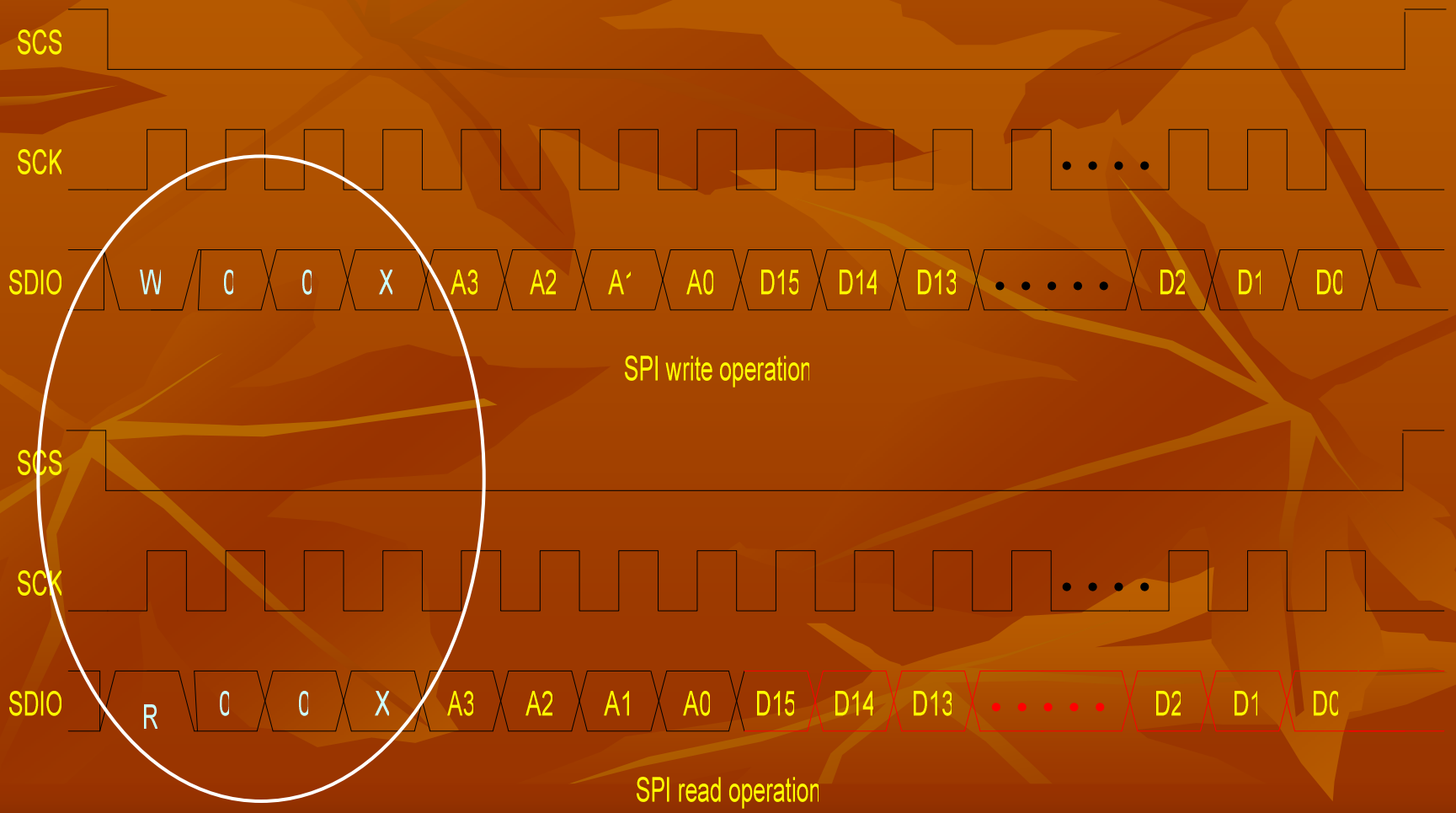


# Wireless system operation

## [00X]: R / W control register



# Wireless system operation

## SPI Command

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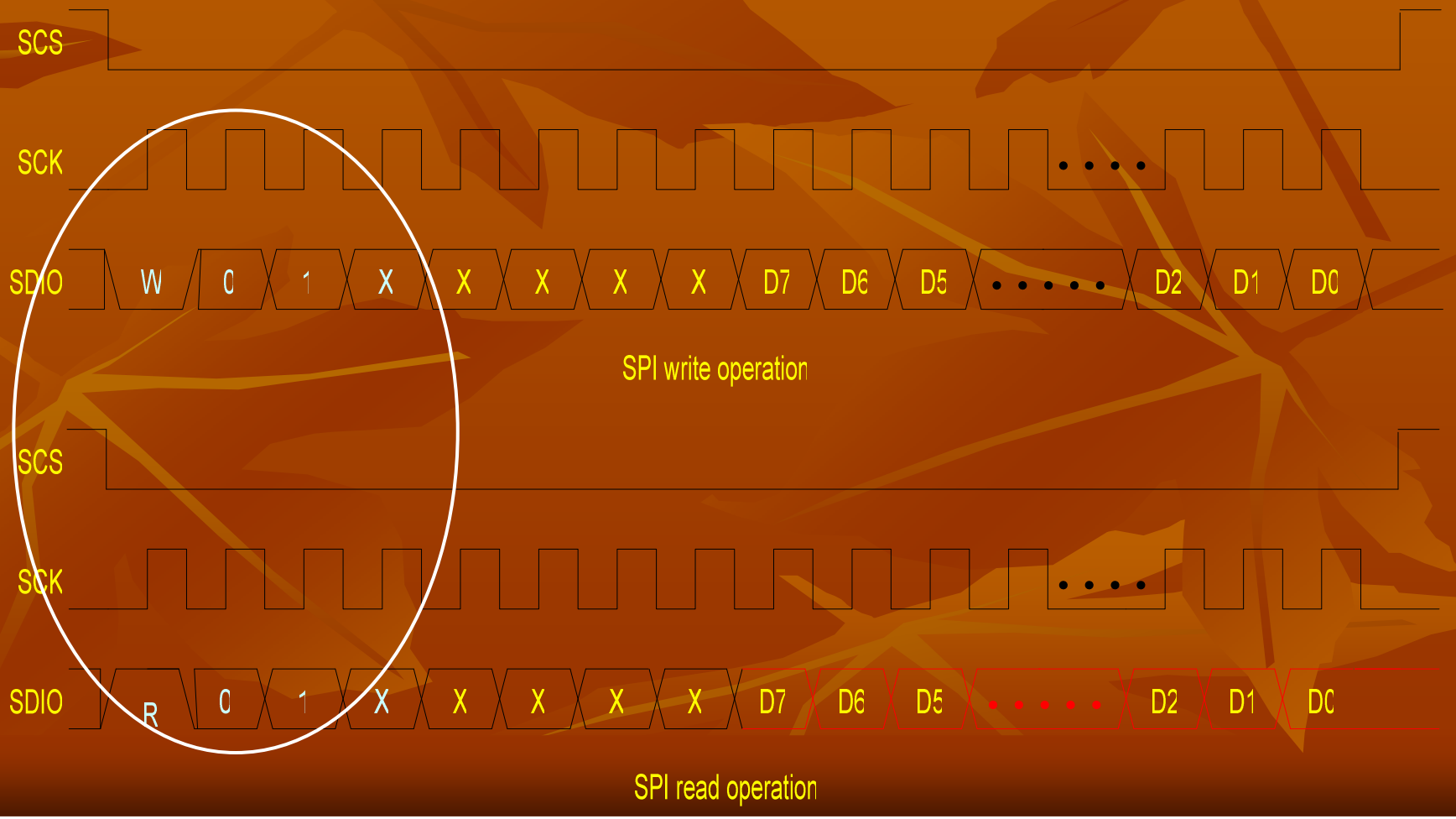
[111]: Reset RF register

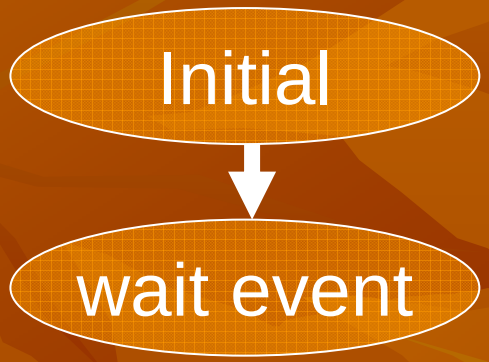
# Wireless system operation

## [01X]: R / W ID code



# Wireless system operation

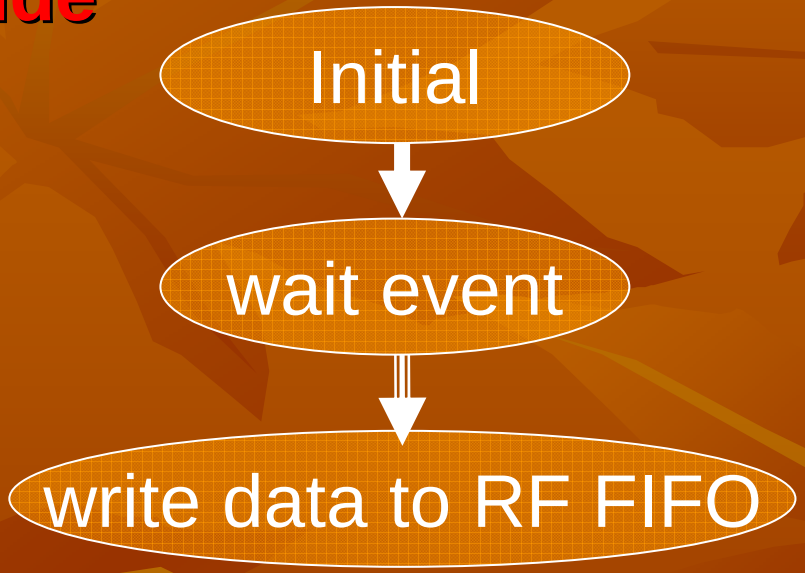
**TX side**




**Key in or signal trigger**

# Wireless system operation

## TX side



# Wireless system operation

## SPI Command

**Bit 7: R/W bit**
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[10X]: R / W FIFO register
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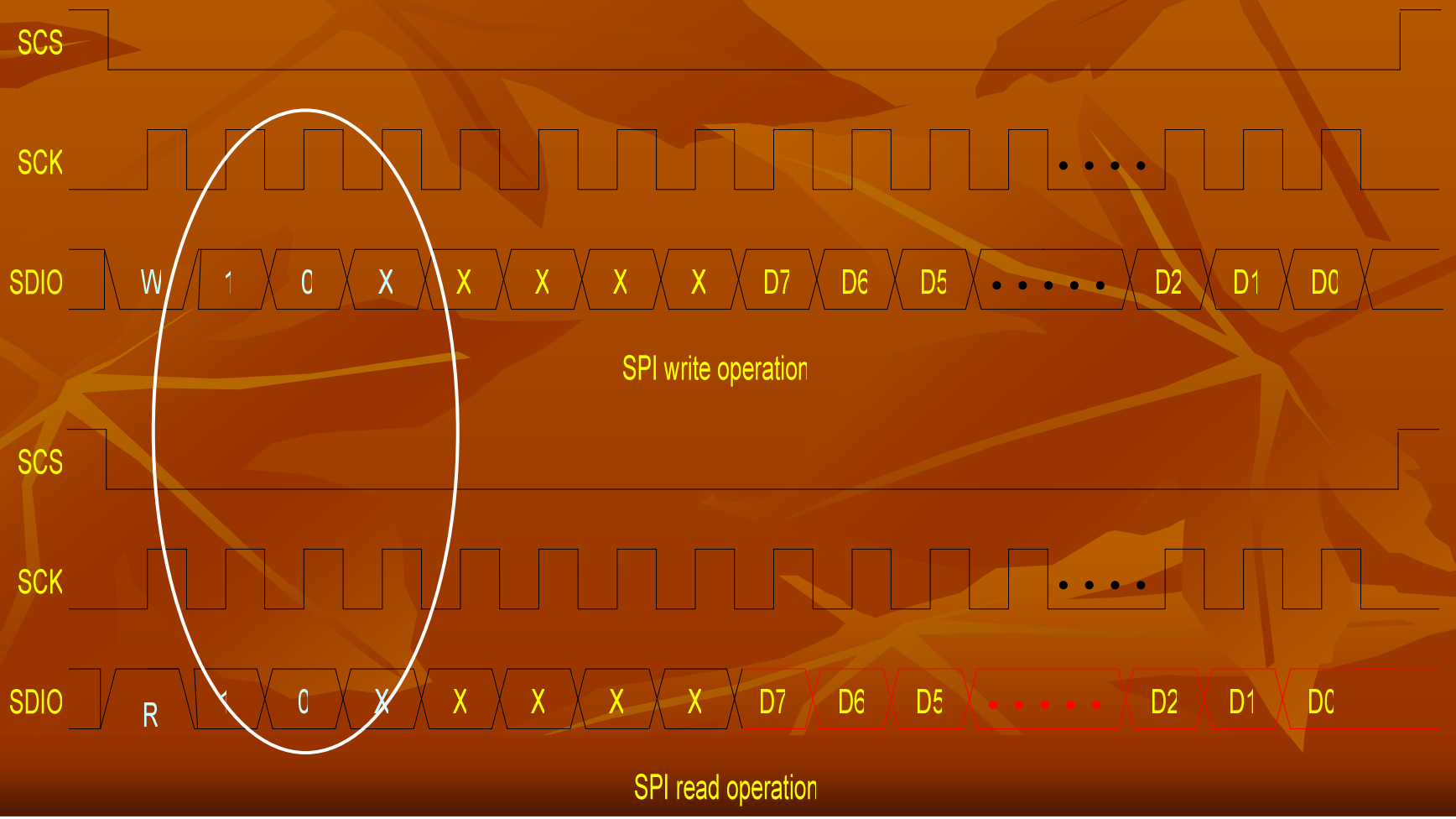
[111]: Reset RF register

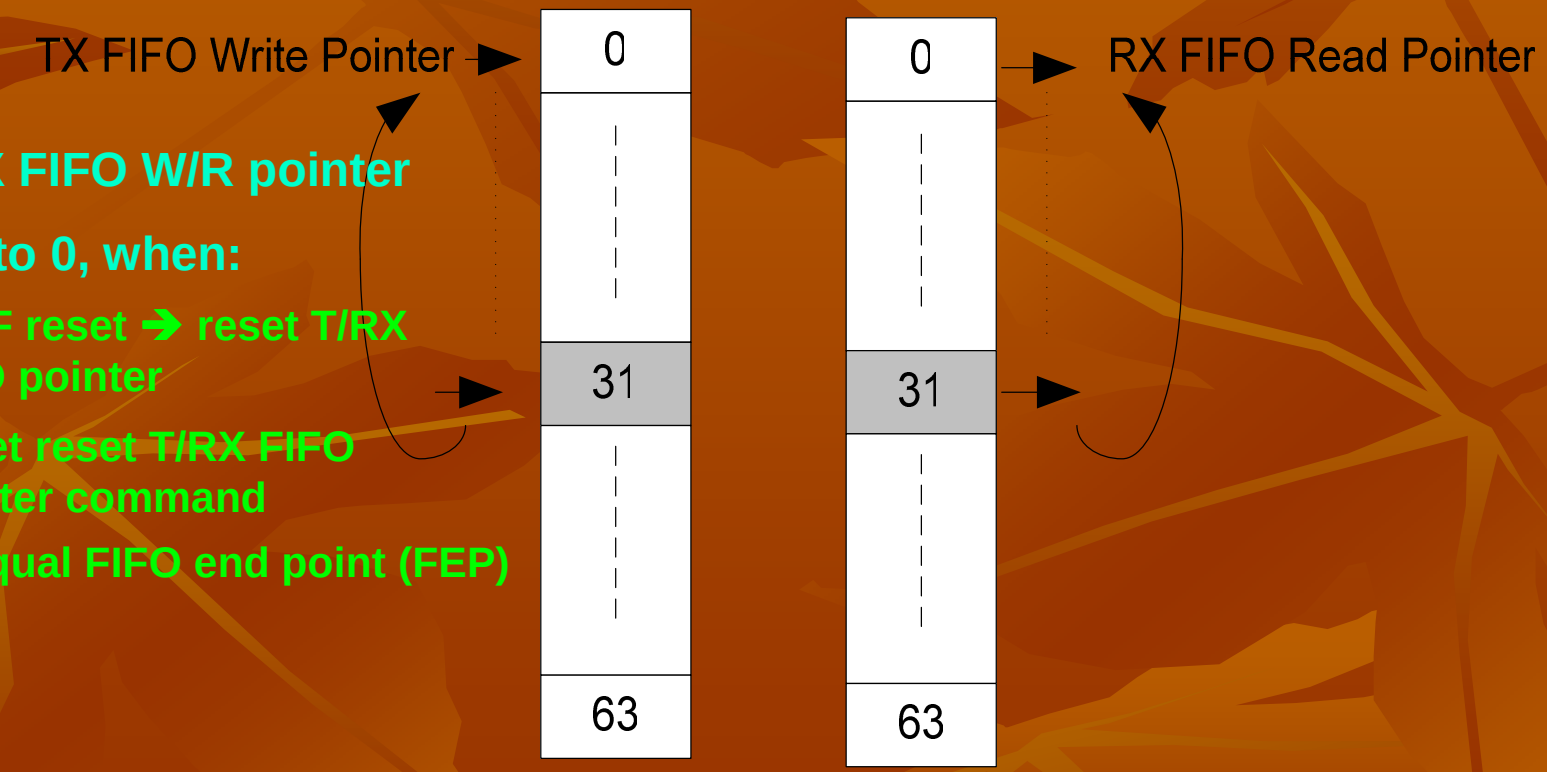
# Wireless system operation

## [10X]: R / W FIFO



# Wireless system operation

## How to use the FIFO



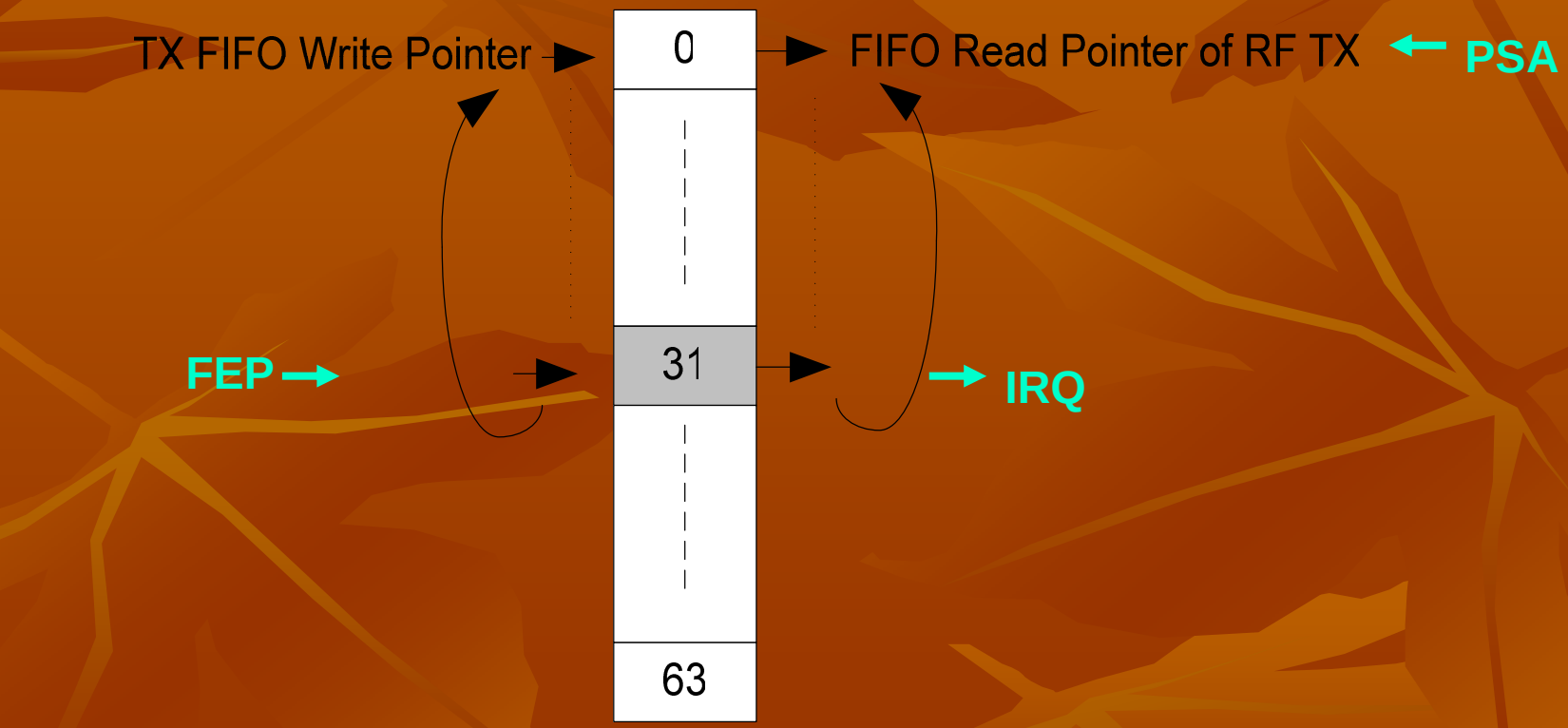

**TRX FIFO W/R pointer**

**set to 0, when:**

1. **RF reset ➔ reset T/RX FIFO pointer**
2. **Set reset T/RX FIFO pointer command**
3. **Equal FIFO end point (FEP)**

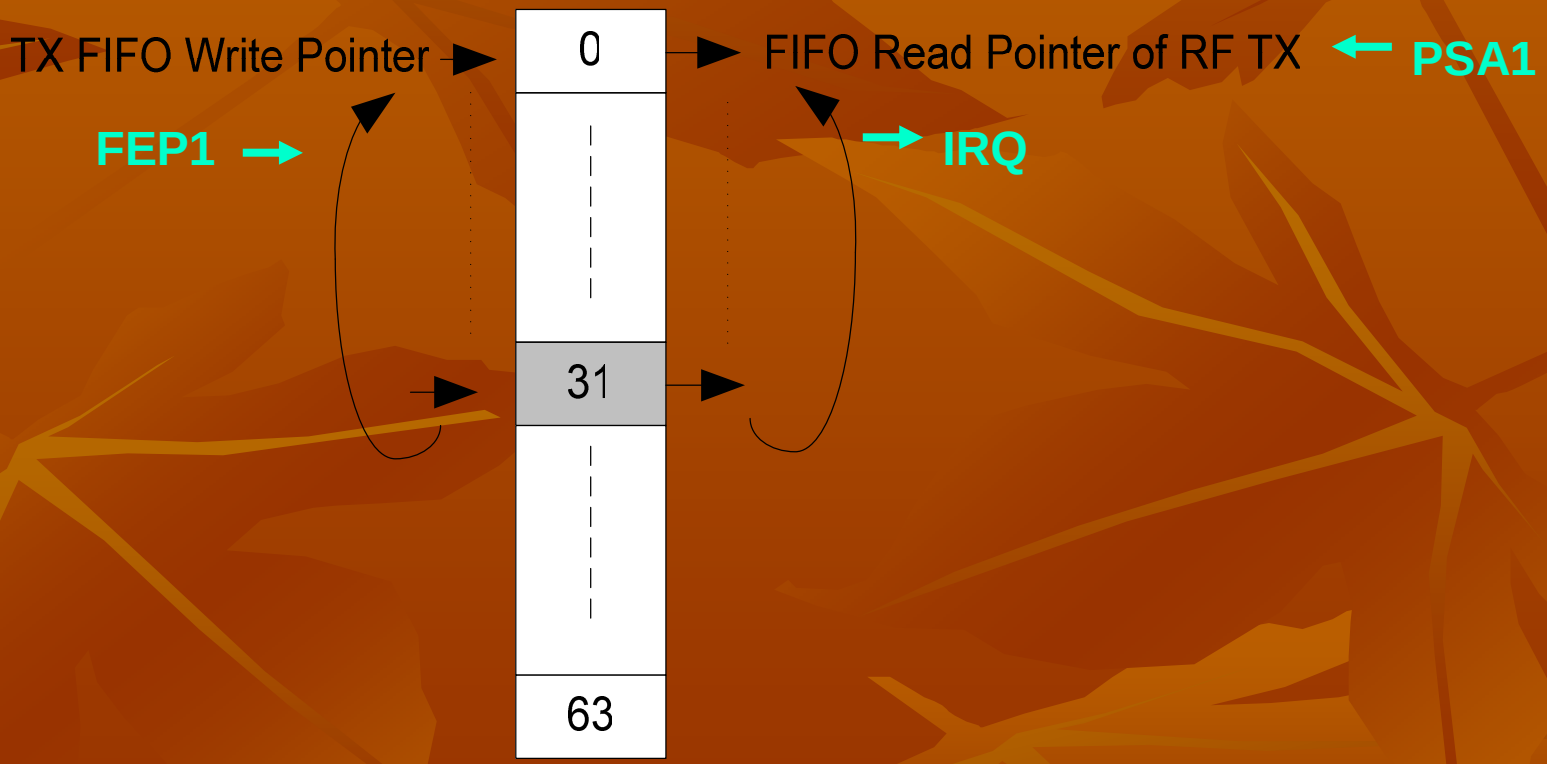
# Wireless system operation

## TX FIFO



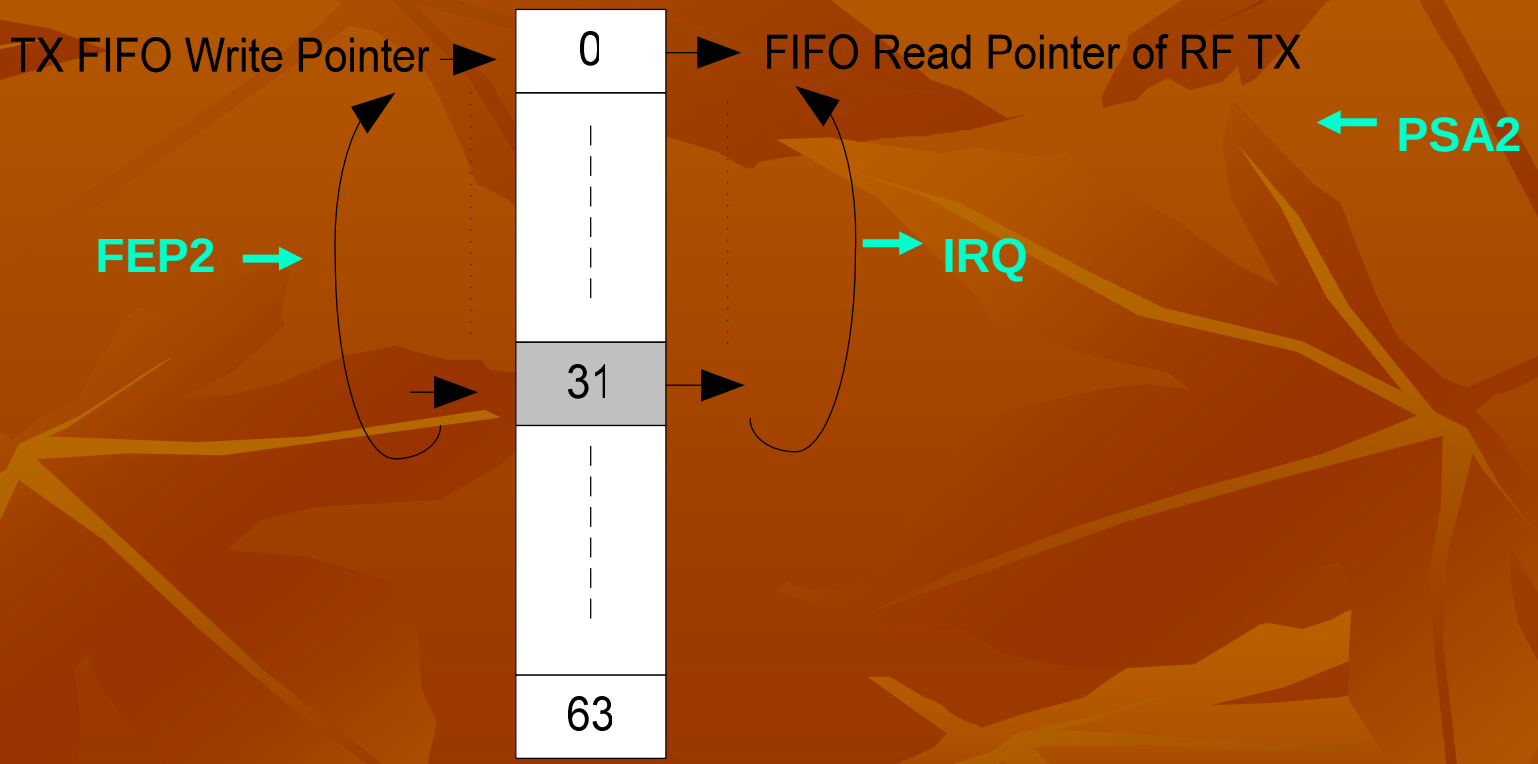
# Wireless system operation

## TX FIFO



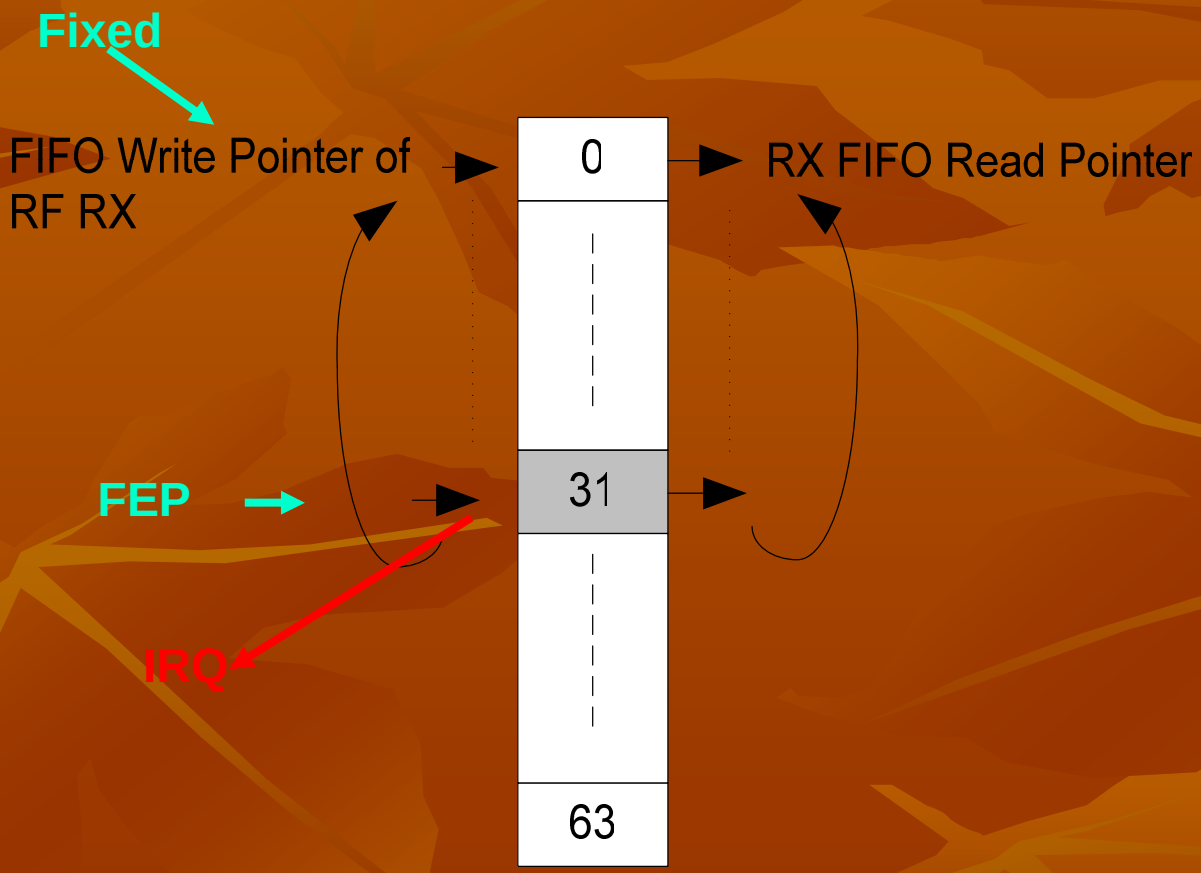
# Wireless system operation

## TX FIFO



# Wireless system operation

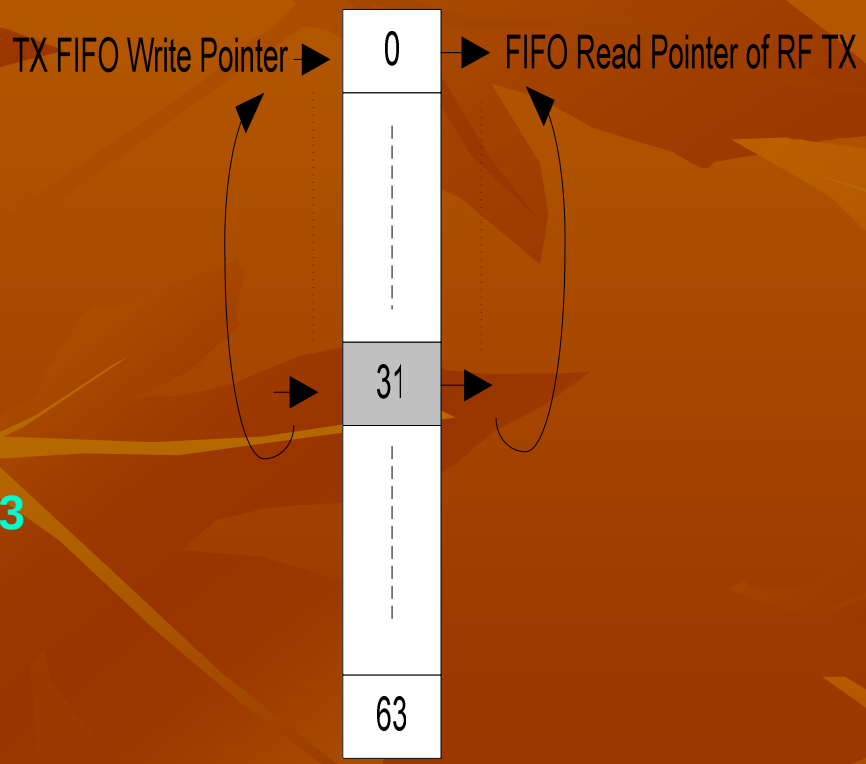
## RX FIFO



# Wireless system operation

## FIFO extend of TX FIFO

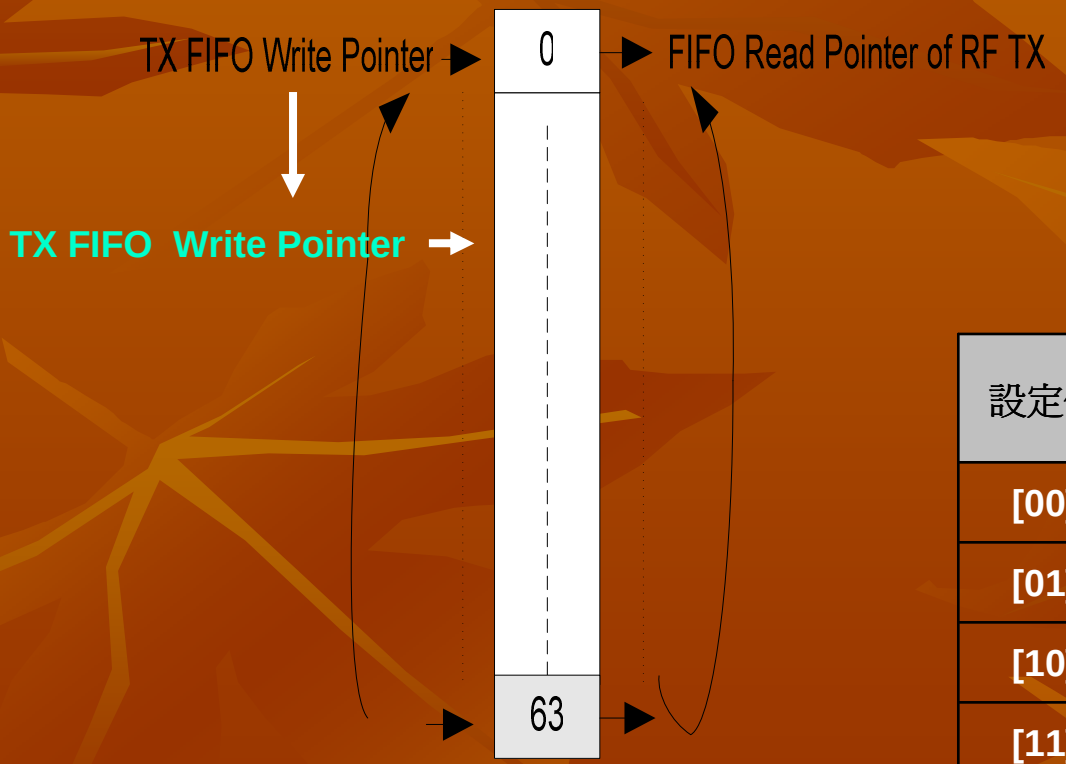
Package size > 64byte




FEP = 63

# Wireless system operation

## FIFO extend of TX FIFO (normal)

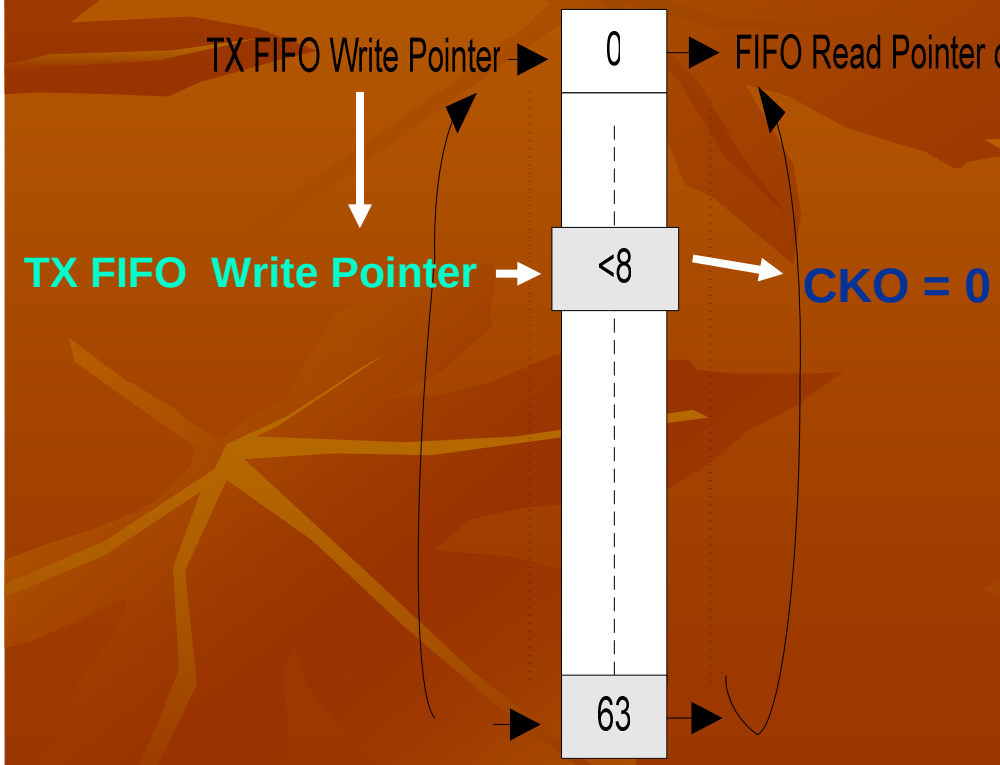



1. Set TX FIFO threshold = 01
2. CKO pin(10,FPF) = 1
3. Write TX FIFO

| 設定值 | Bytes in TX FIFO | Bytes in RX FIFO |
|---|---|---|
| [00] | 4 | 60 |
| [01] | 8 | 56 |
| [10] | 12 | 52 |
| [11] | 16 | 48 |

# Wireless system operation

## FIFO extend of TX FIFO (normal)

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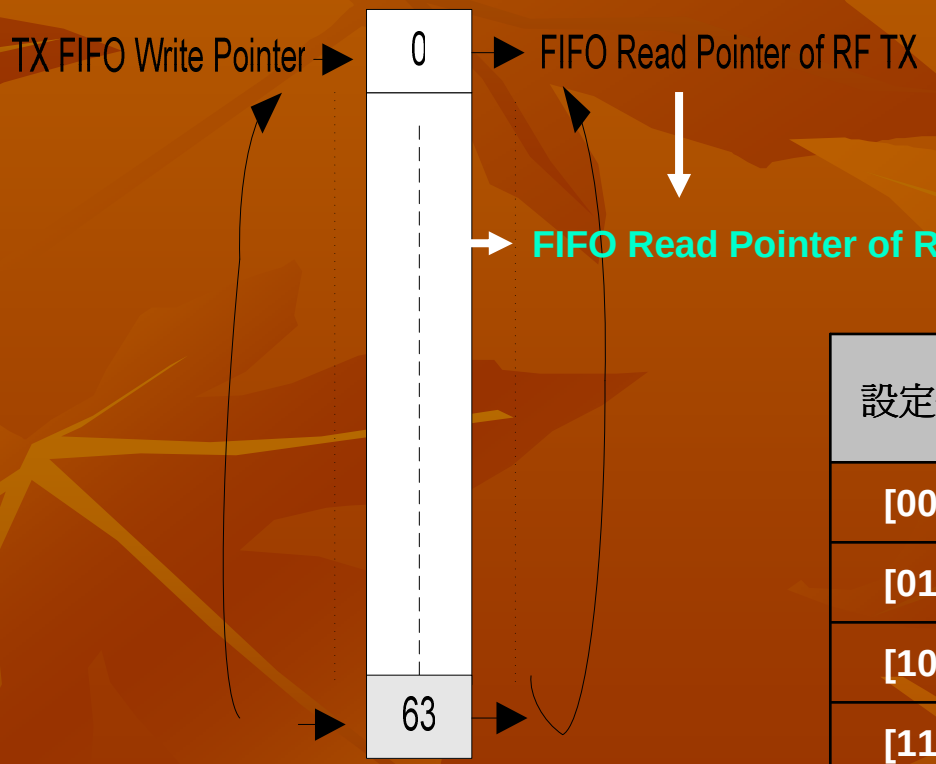
| [11] | 16 | 48 |

# Wireless system operation

## FIFO extend of TX FIFO (non-normal)

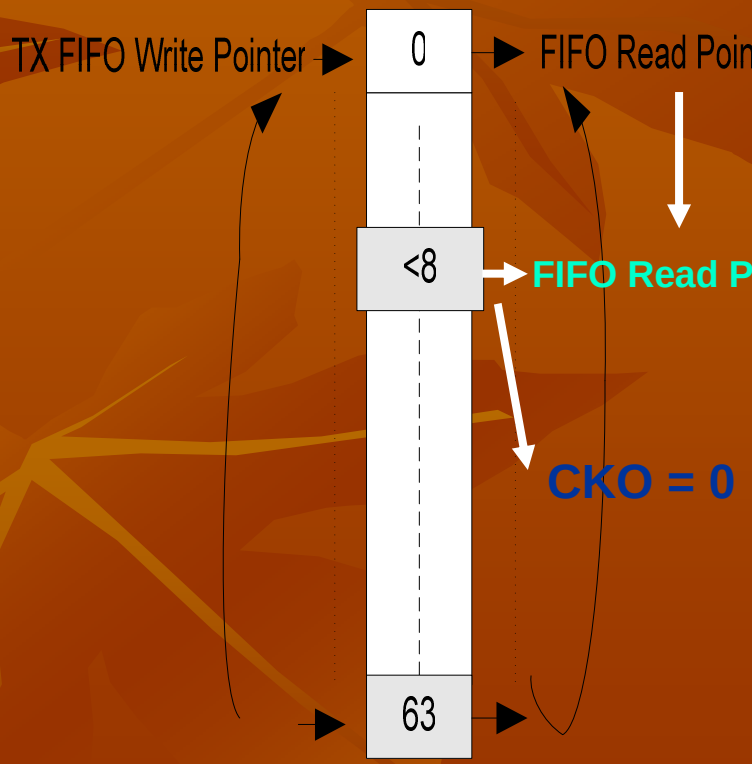



1. Set TX FIFO threshold = 01
2. CKO pin(10,FPF) = 1
3. Write TX FIFO

| 設定值 | Bytes in TX FIFO | Bytes in RX FIFO |
|---|---|---|
| [00] | 4 | 60 |
| [01] | 8 | 56 |
| [10] | 12 | 52 |
| [11] | 16 | 48 |

# Wireless system operation

## FIFO extend of TX FIFO (non-normal)




1. Set TX FIFO threshold = 01
2. CKO pin(10,FPF) = 1
3. Write TX FIFO

| 設定值 | Bytes in TX FIFO | Bytes in RX FIFO |
|---|---|---|
| [00] | 4 | 60 |
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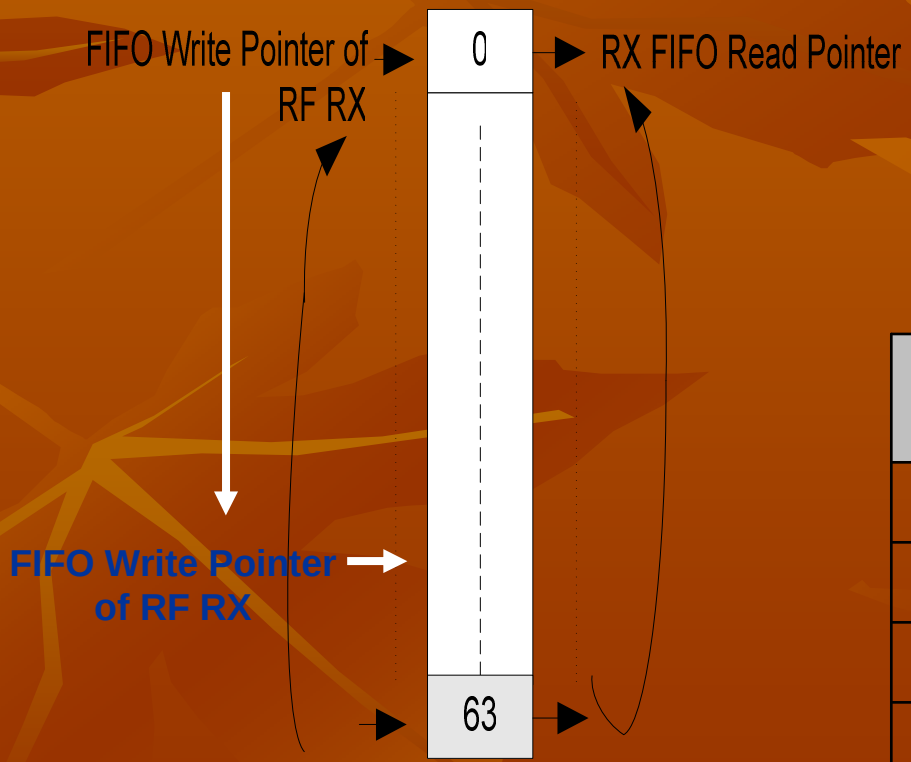
| [11] | 16 | 48 |

# Wireless system operation

## FIFO extend of RX FIFO (normal)




1. Set RX FIFO threshold = 01
2. CKO pin(10,FPF) = 0
3. RF Write data to RX FIFO

| 設定值 | Bytes in TX FIFO | Bytes in RX FIFO |
|---|---|---|
| [00] | 4 | 60 |
| [01] | 8 | 56 |
| [10] | 12 | 52 |
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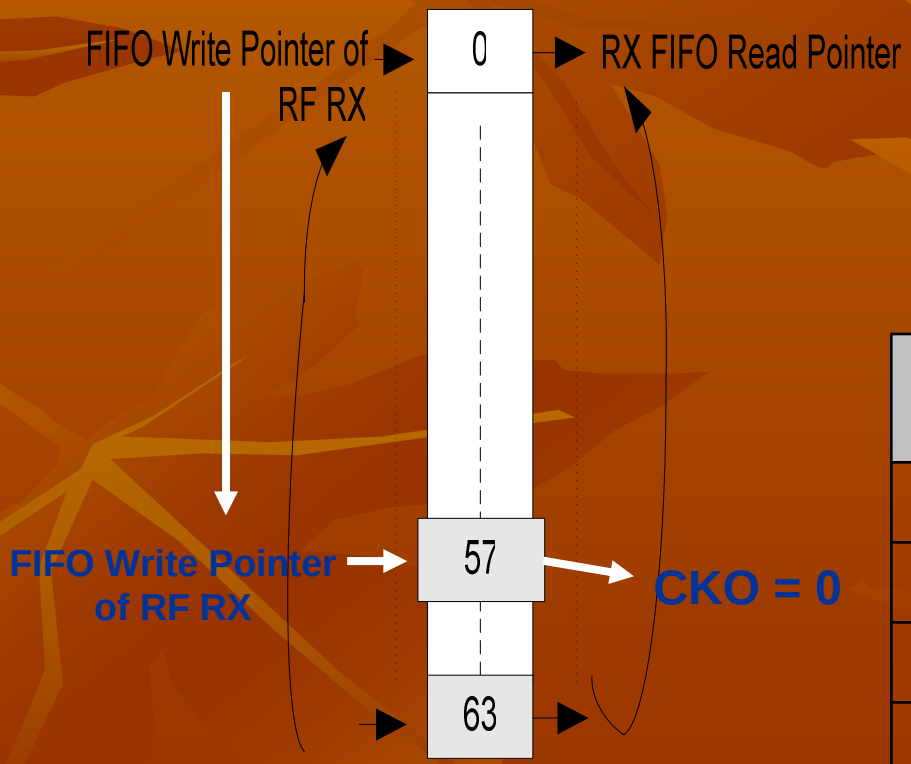
# Wireless system operation

## FIFO extend of RX FIFO (normal)




1. Set RX FIFO threshold = 01
2. CKO pin(10,FPF) = 0
3. RF Write data to RX FIFO

| 設定值 | Bytes in TX FIFO | Bytes in RX FIFO |
|---|---|---|
| [00] | 4 | 60 |
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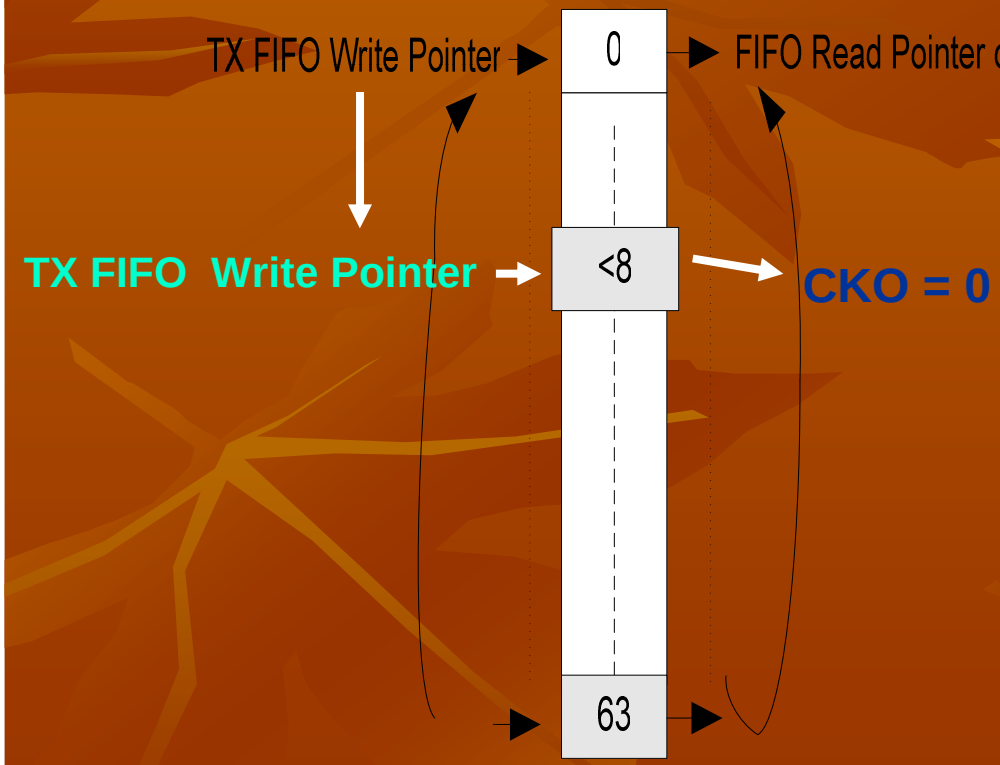
# Wireless system operation

## FIFO extend of TX FIFO (normal)

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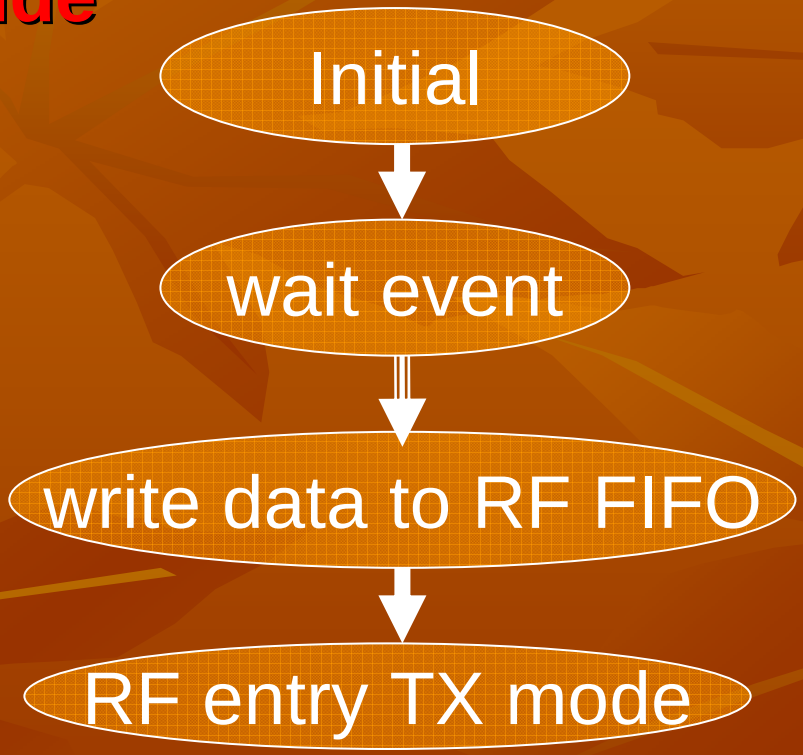
# Wireless system operation

## SPI control access type

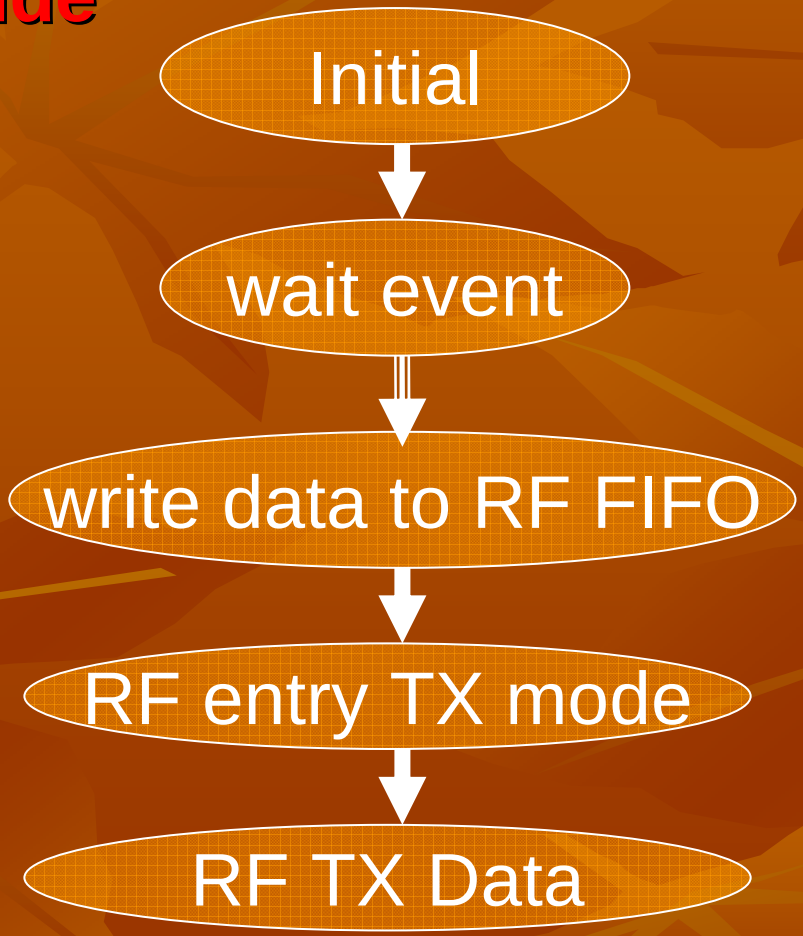
# Wireless system operation

## TX side



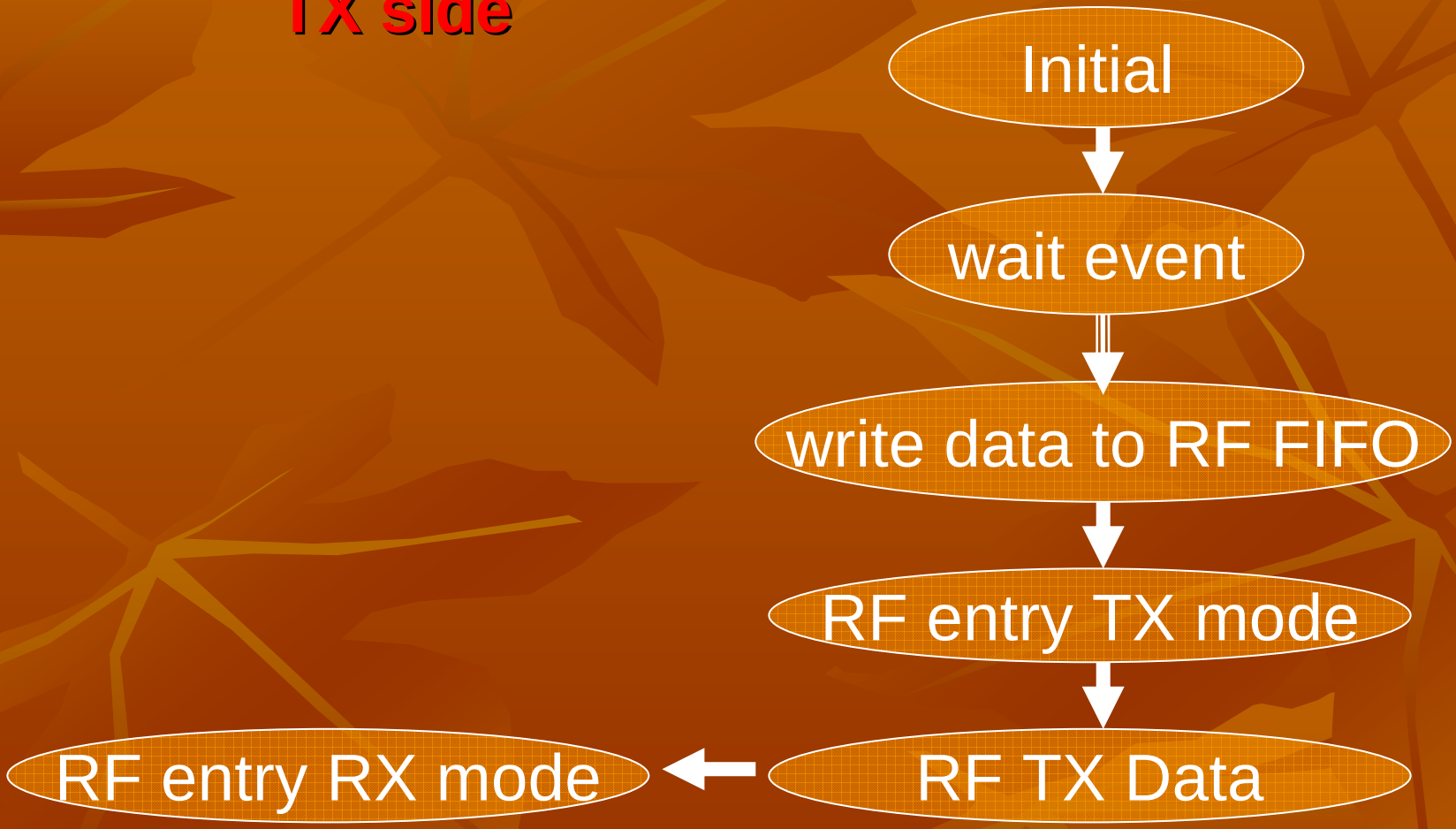
# Wireless system operation

## TX side



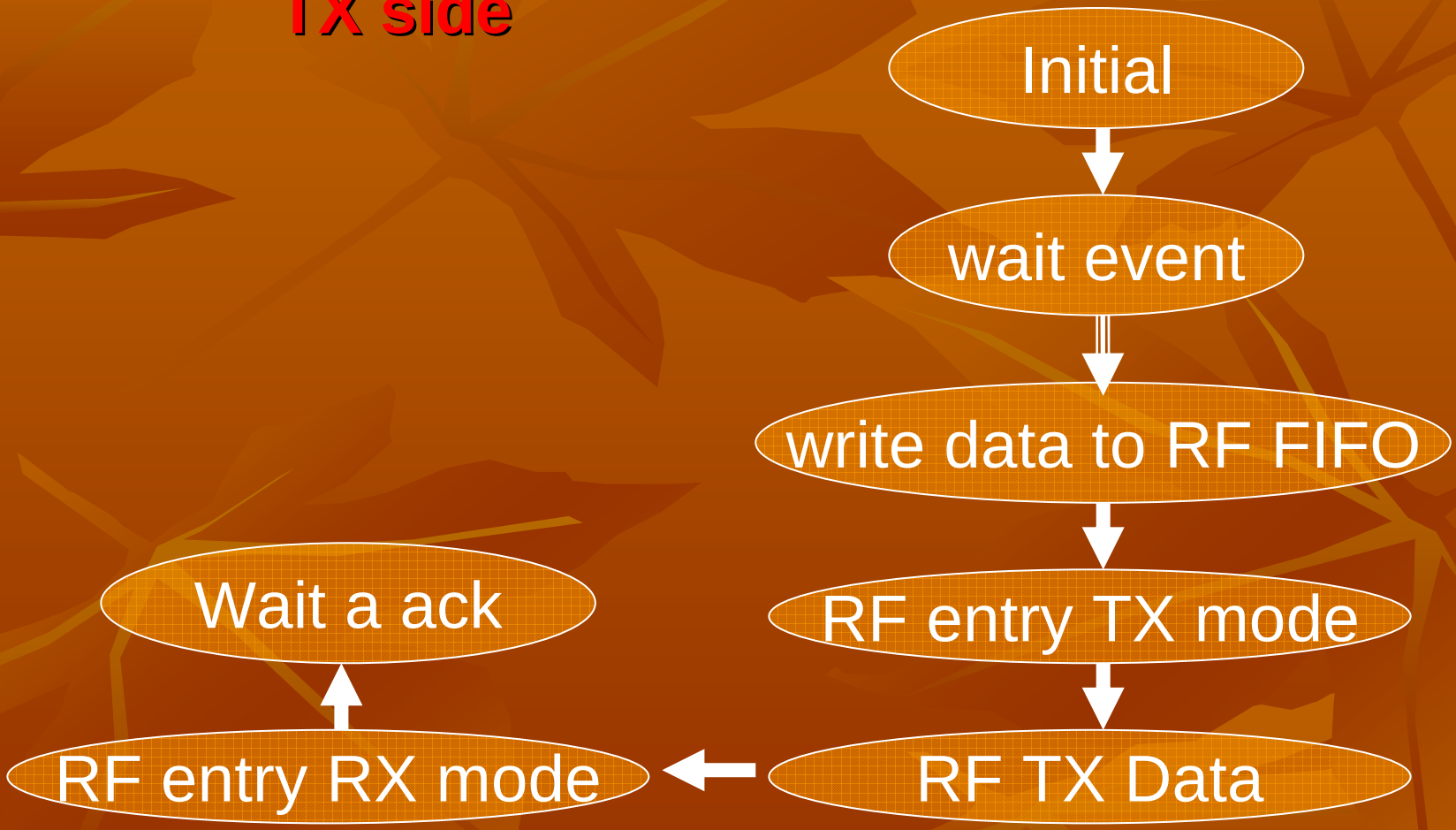
# Wireless system operation

## TX side

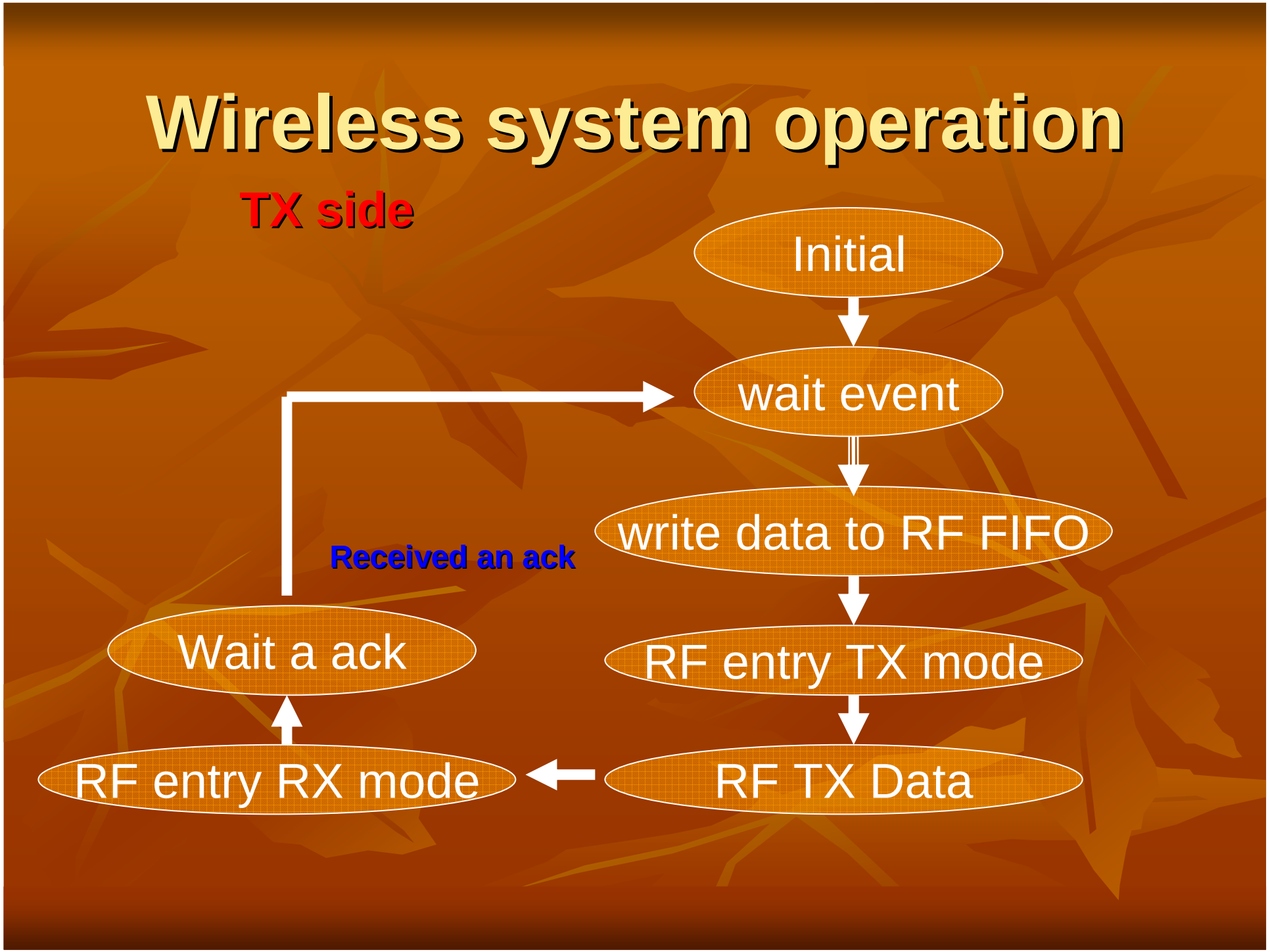


# Wireless system operation

## TX side



# Wireless system operation



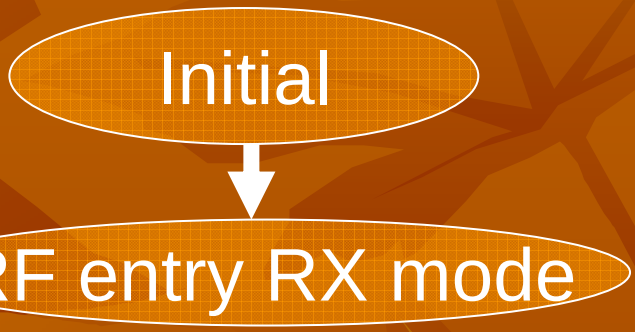
# Wireless system operation

## RX side

Initial

# Wireless system operation

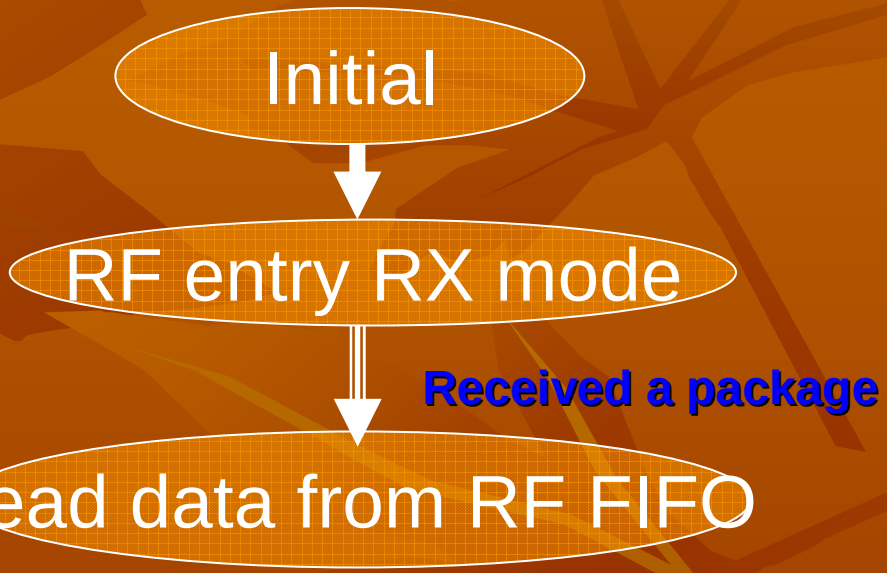
## RX side




Pin_RQ(IRQ_R:01)

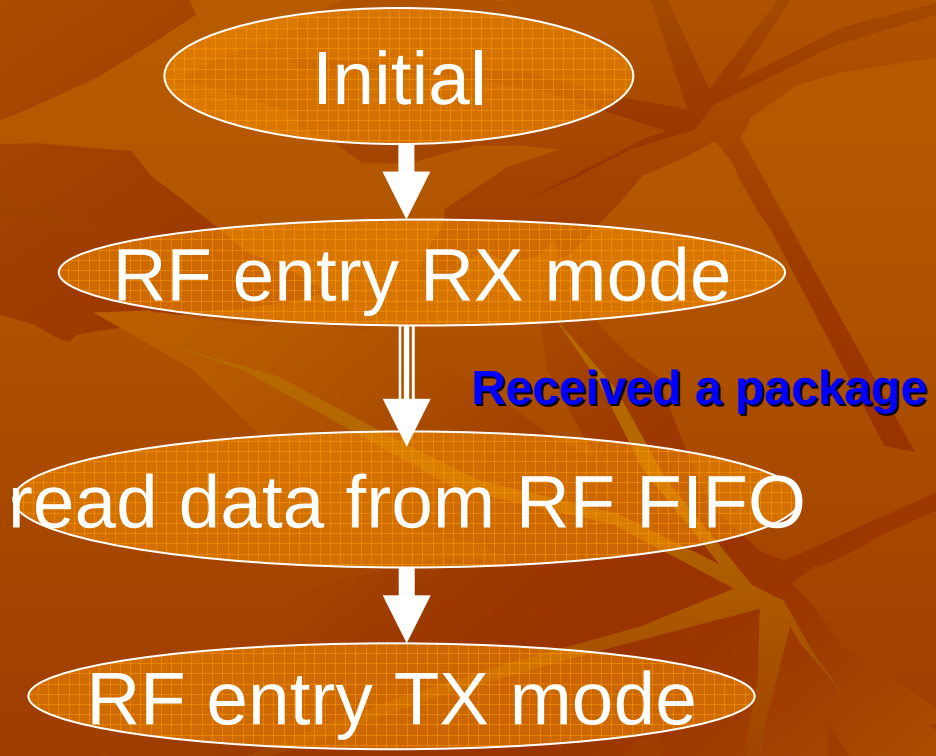
# Wireless system operation

## RX side



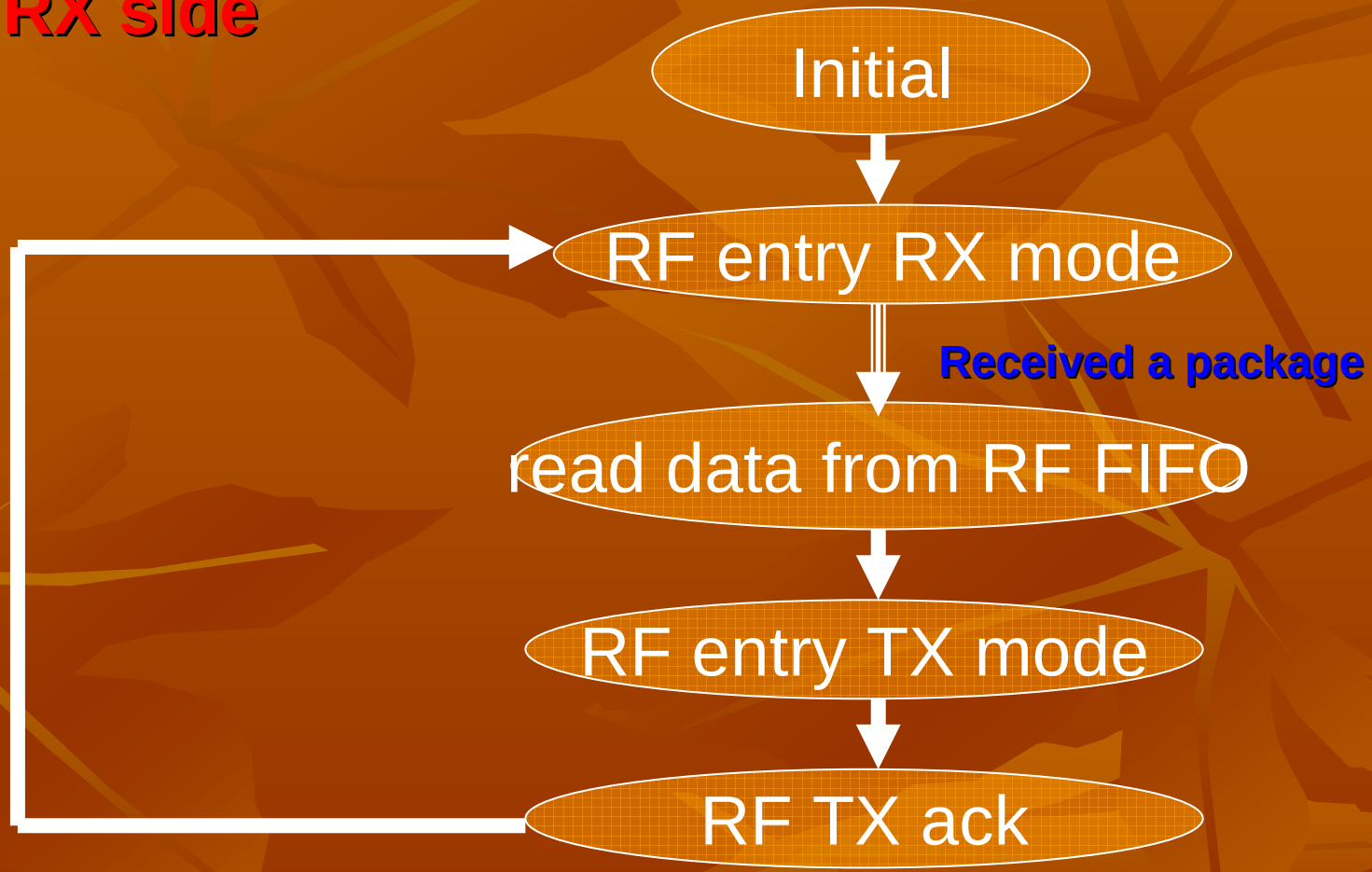
# Wireless system operation

## RX side



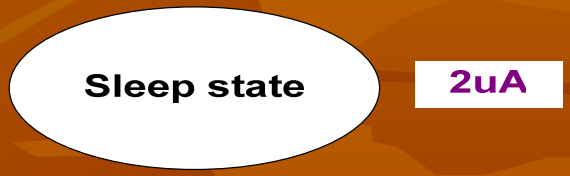
# Wireless system operation

## RX side



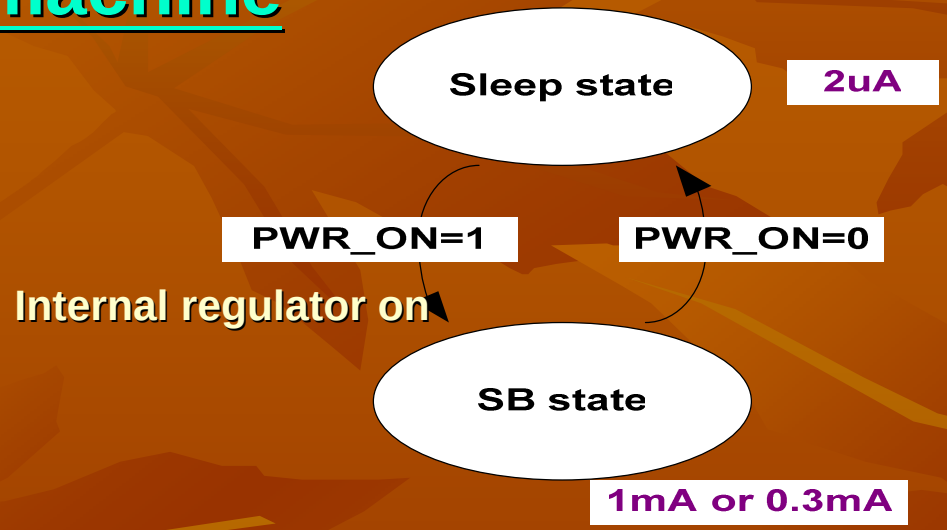
# Wireless system operation

## RF state machine



# Wireless system operation

## RF state machine



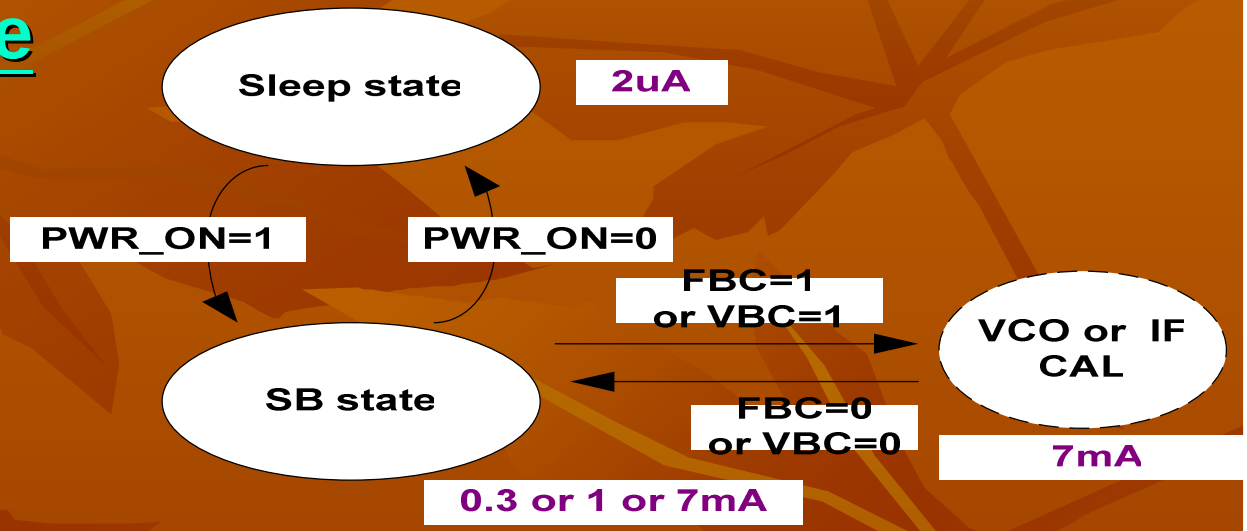

SB mode1, XOSC off, band gap off, PLL off( CER=0, PLLE=0)

SB mode2, XOSC on, band gap on, PLL off( CER=1, PLLE=0)

SB mode3, XOSC on, band gap on, PLL on( CER=1, PLLE=1)

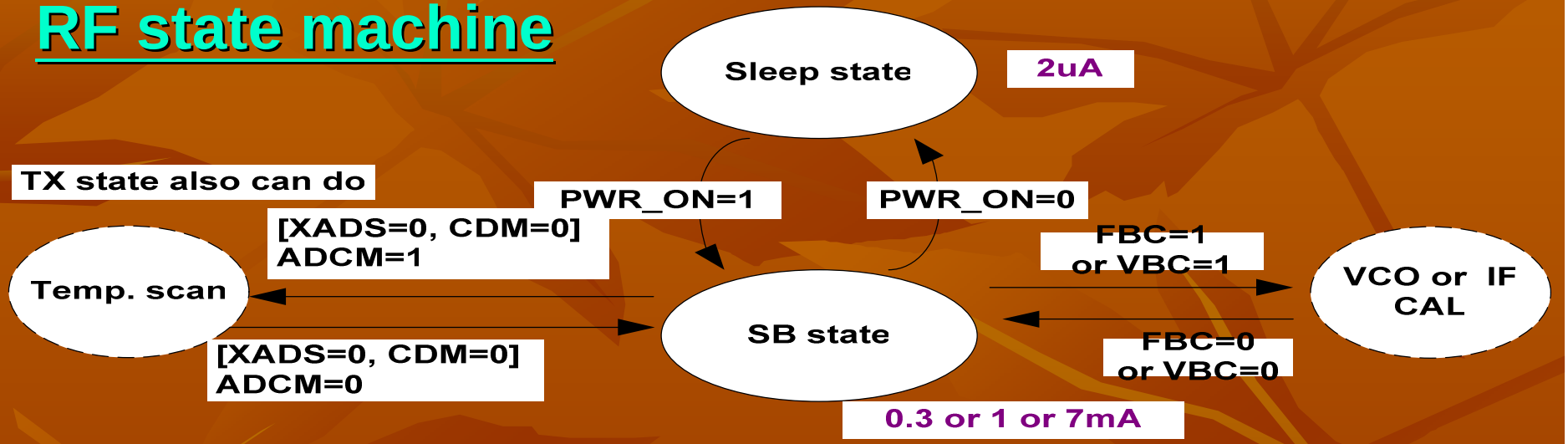
# Wireless system operation

## RF state machine



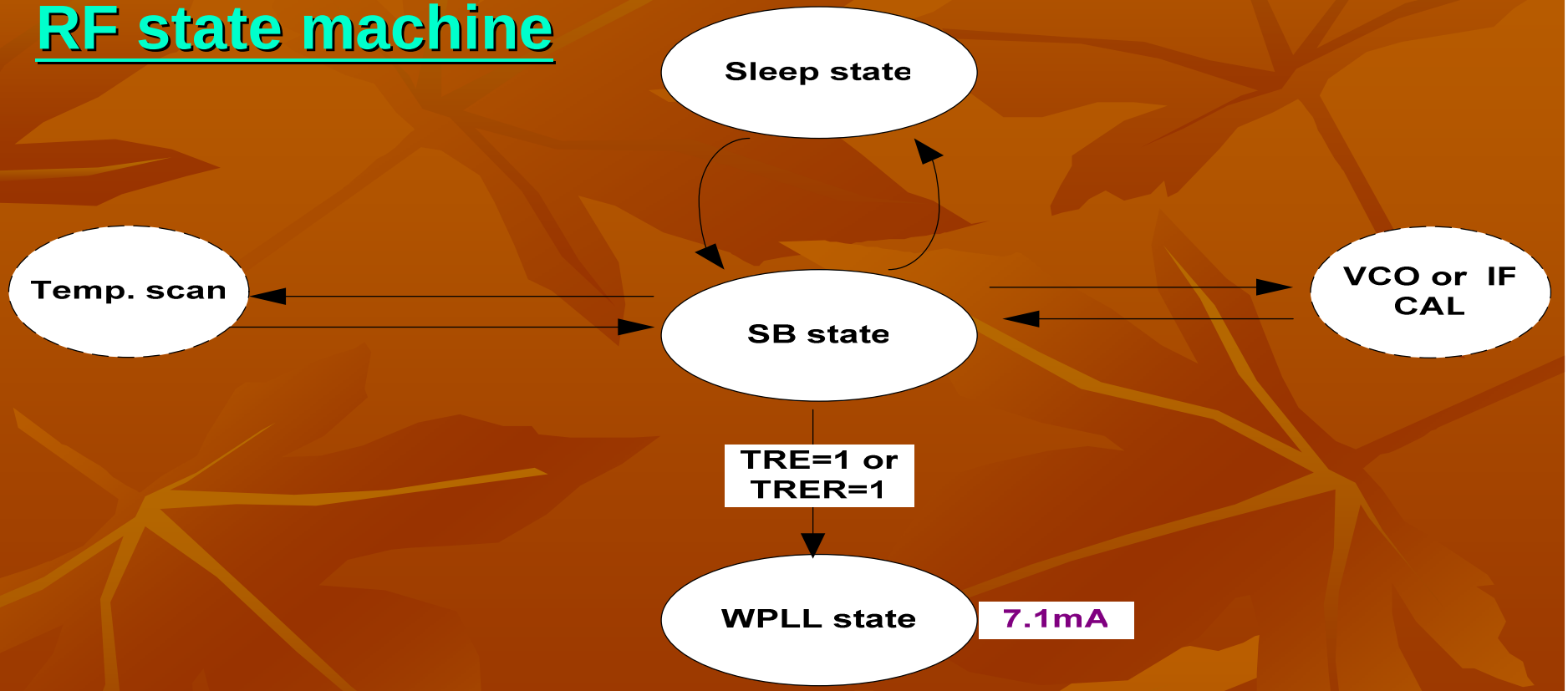
# Wireless system operation

## RF state machine



# Wireless system operation

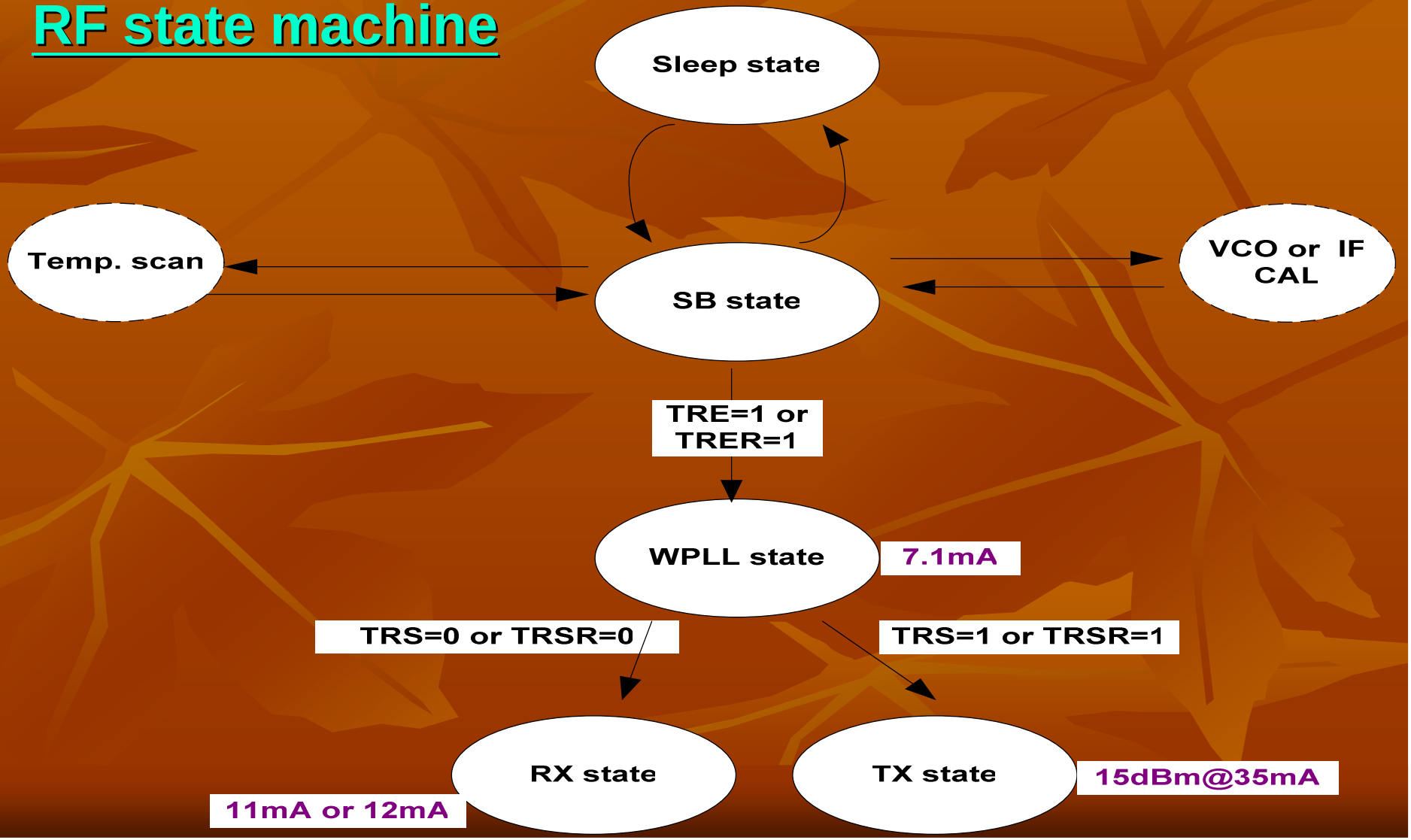
## RF state machine




SB mode1, can't be used for auto mode back
SB mode2, wait PLL + TX / RX settling time ~ 80us +80us
SB mode3, wait TX / RX settling time~80us

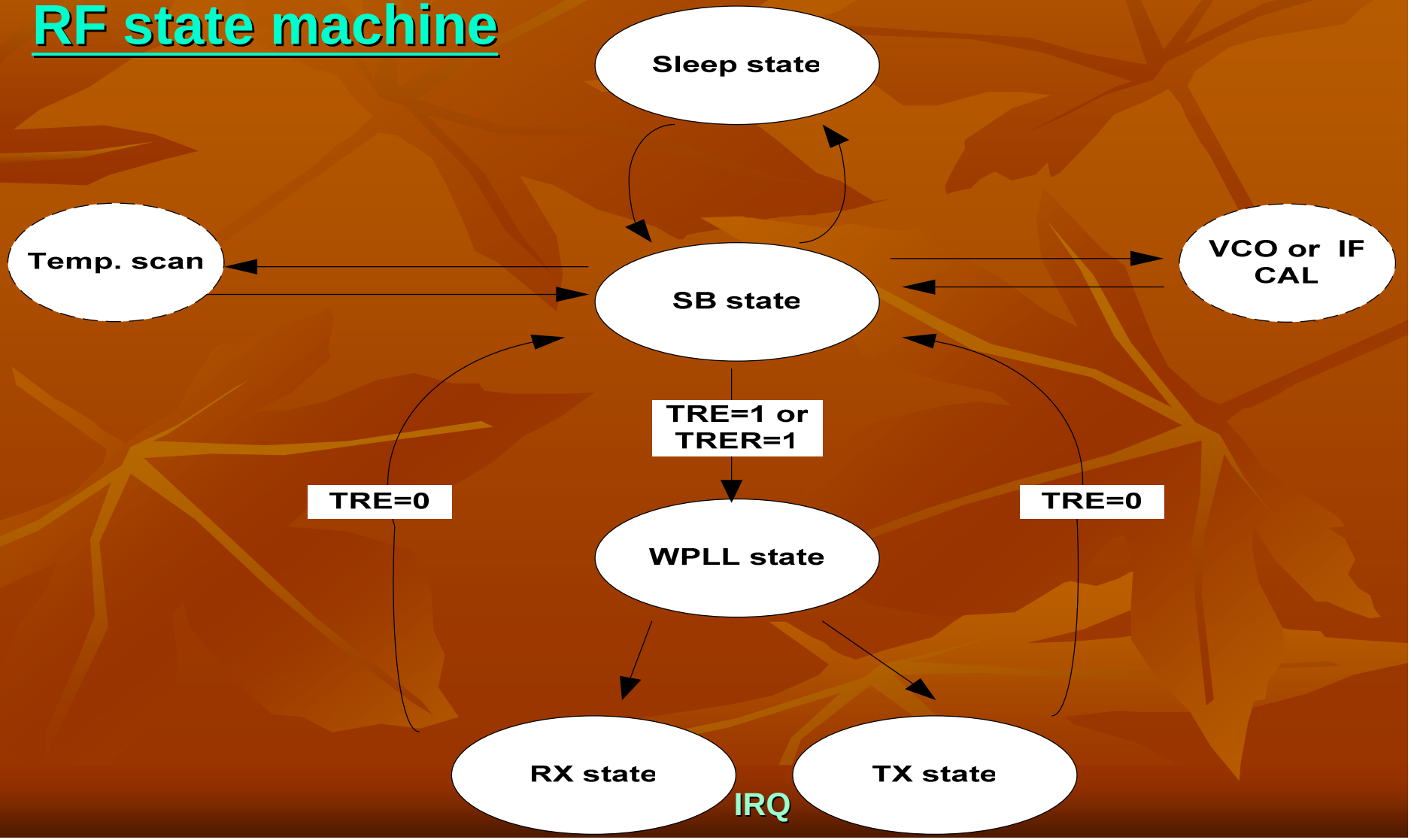
# Wireless system operation

## RF state machine



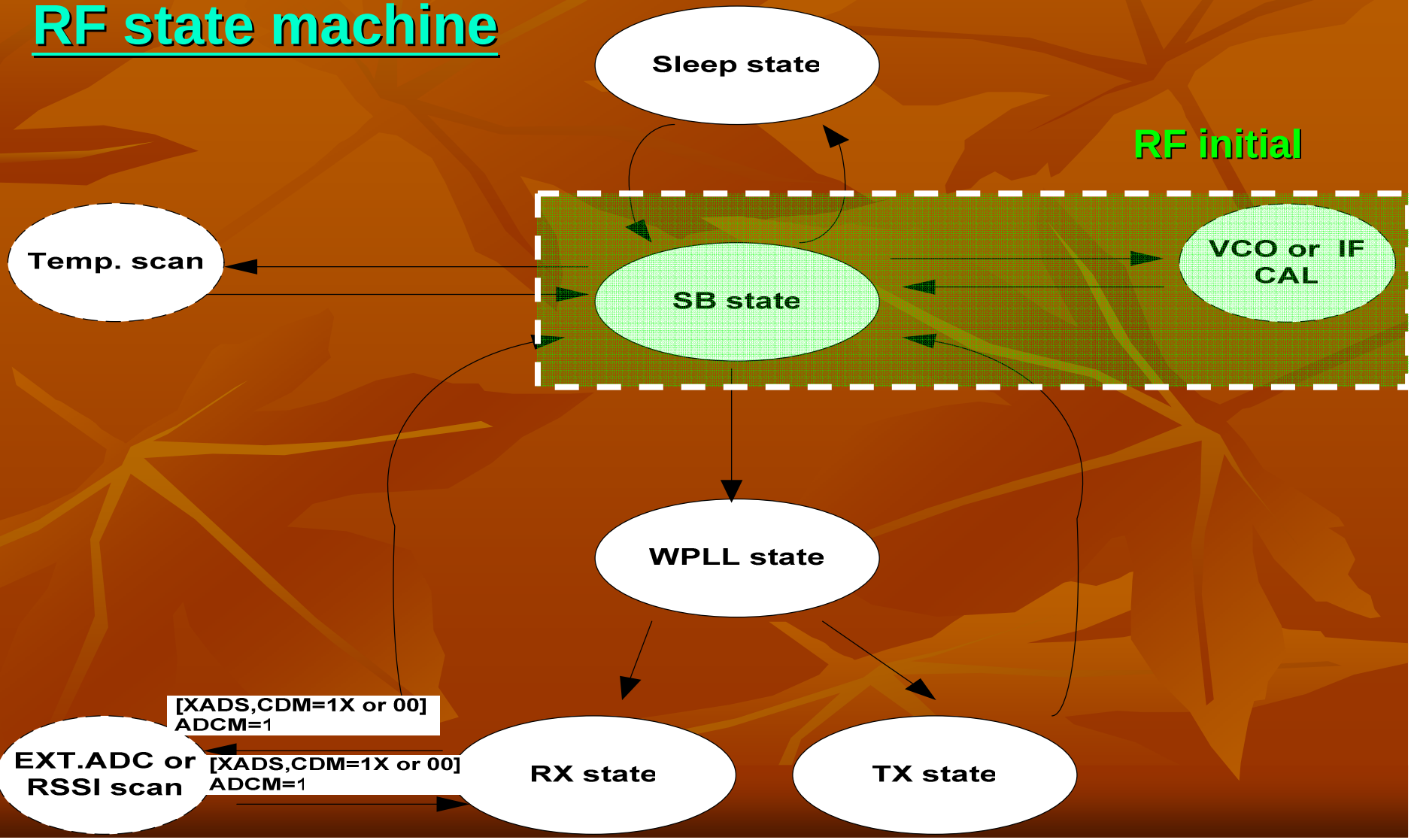
# Wireless system operation

## RF state machine



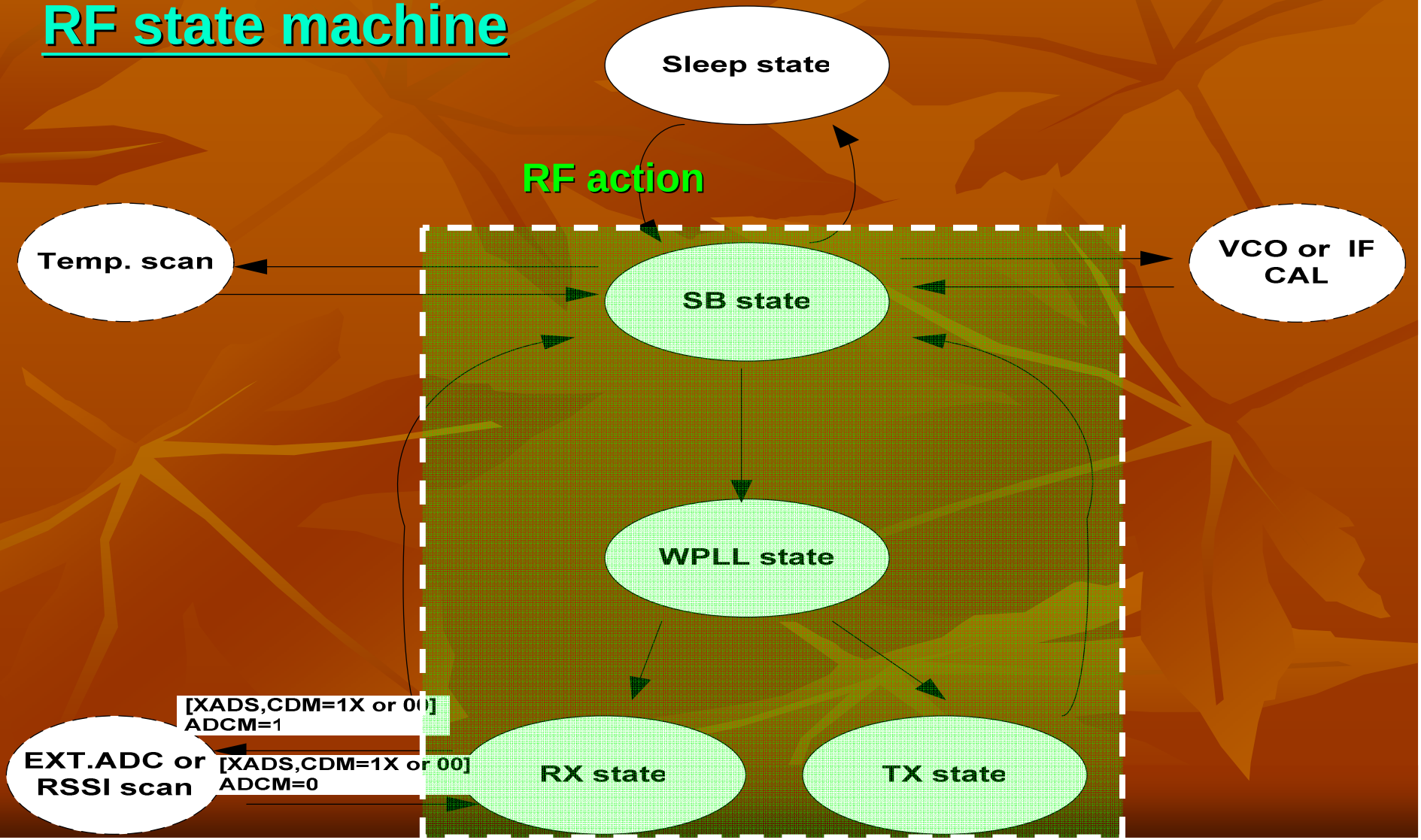
# Wireless system operation

## RF state machine



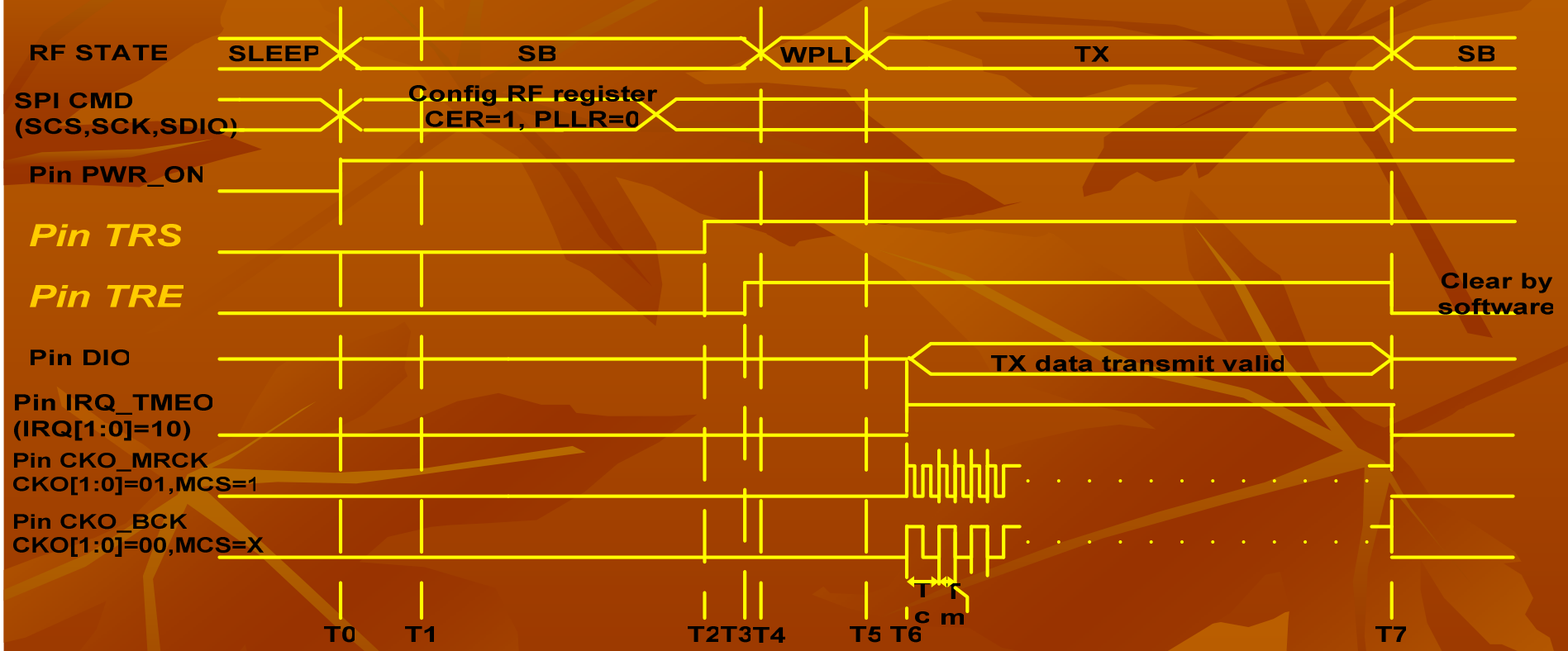
# Wireless system operation

## RF state machine



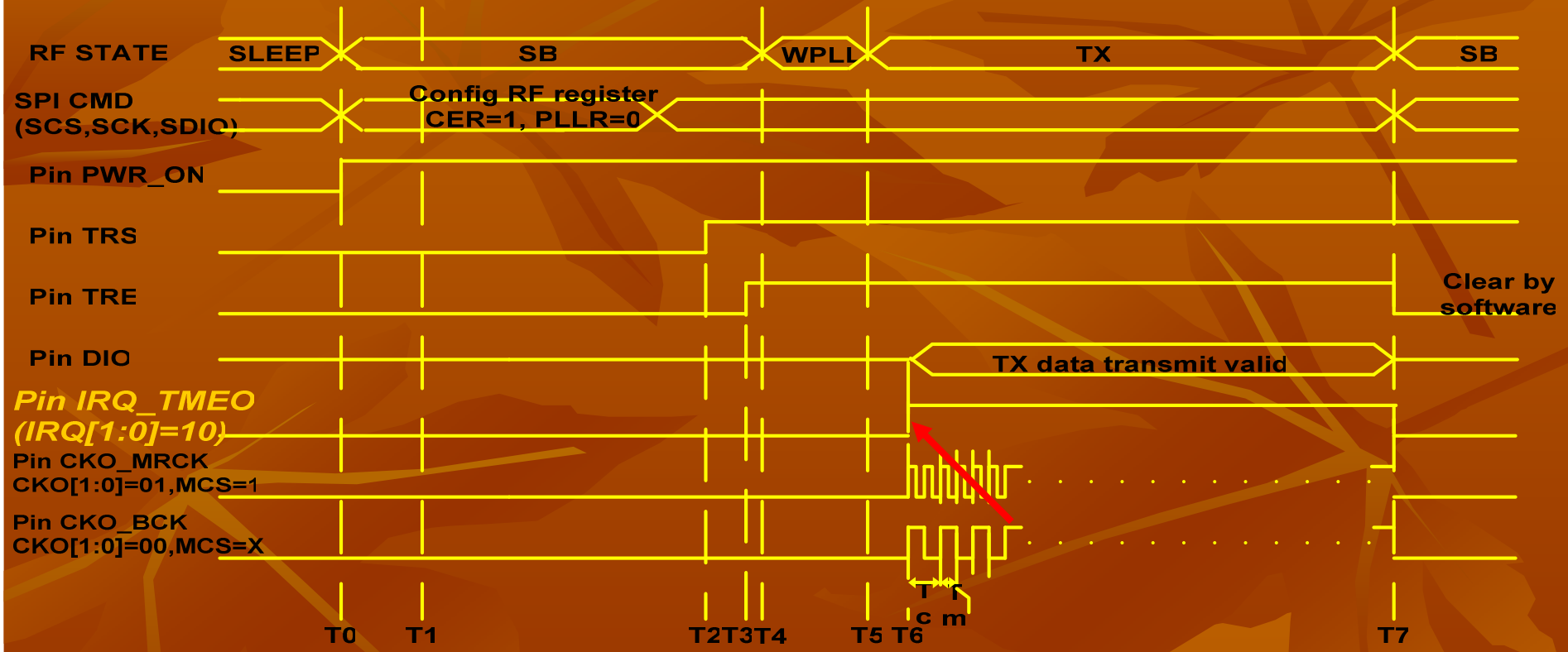
# Wireless system operation

## TX timing (Direct)



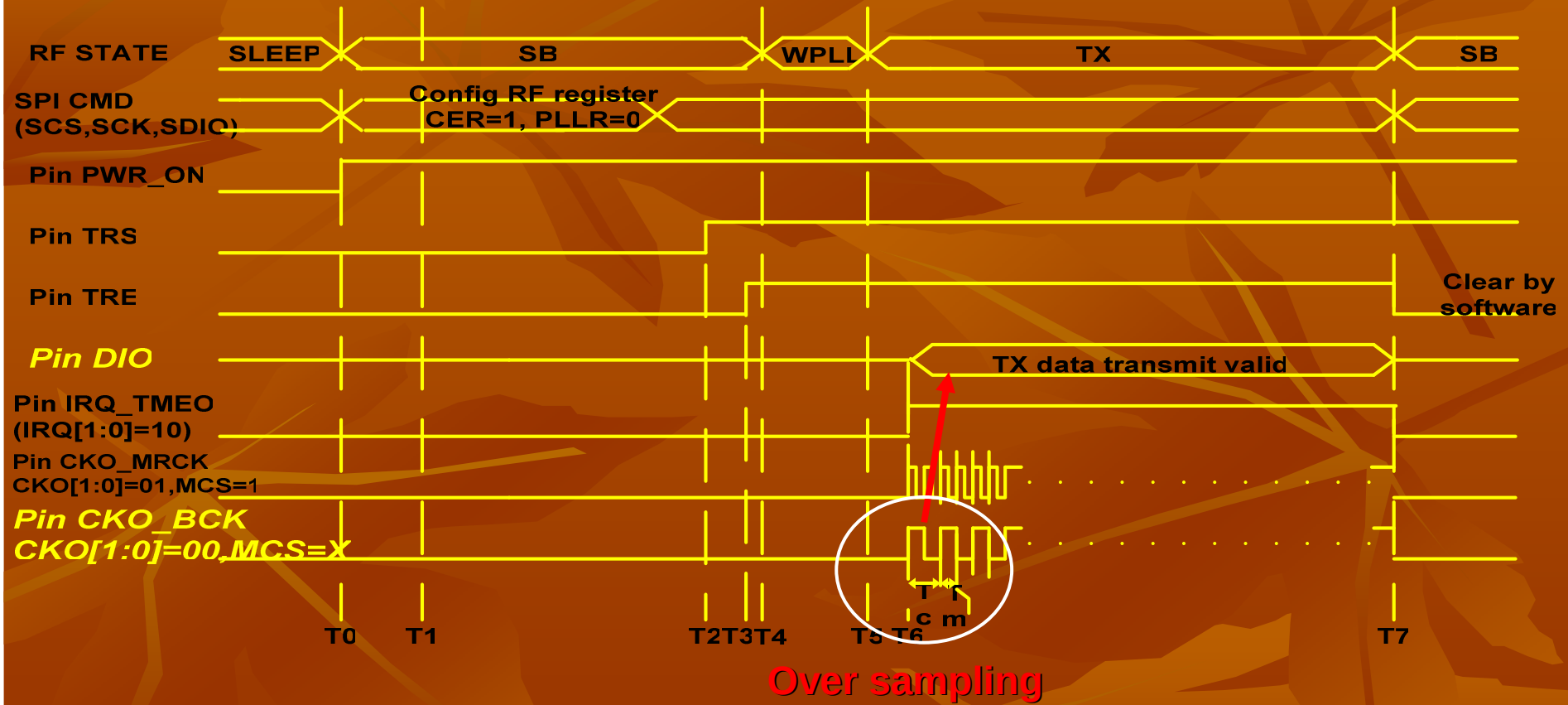
# Wireless system operation

## TX timing (Direct)



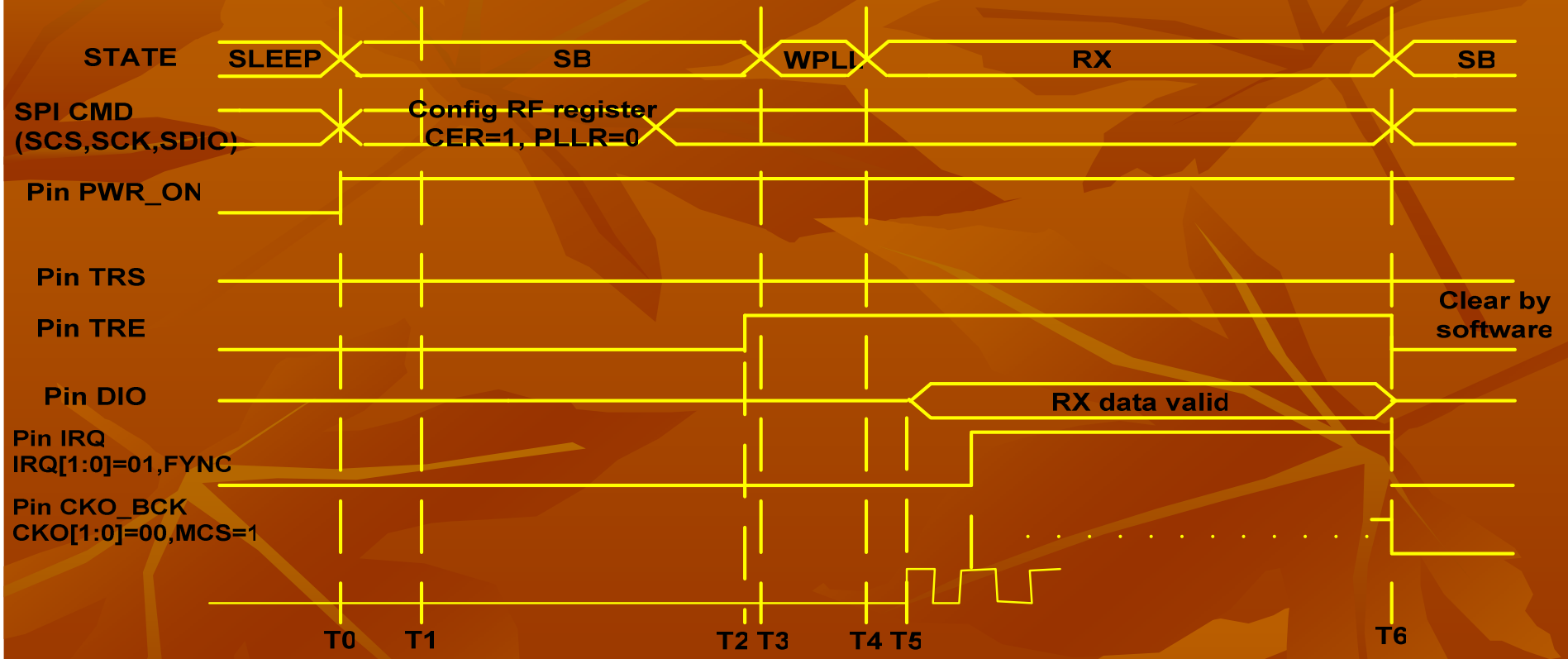
# Wireless system operation

## TX timing (Direct)



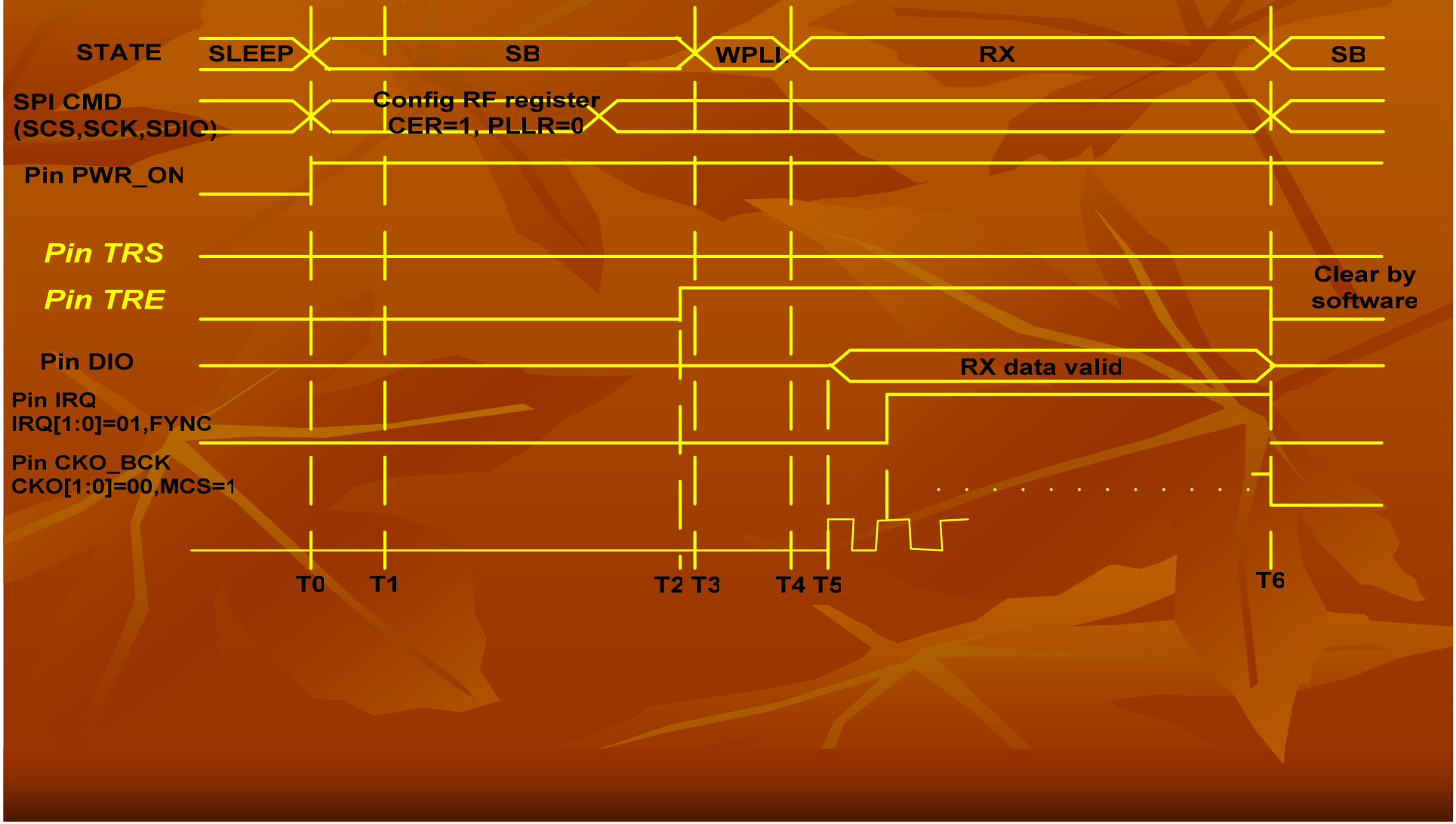
# Wireless system operation

## RX timing (Direct)



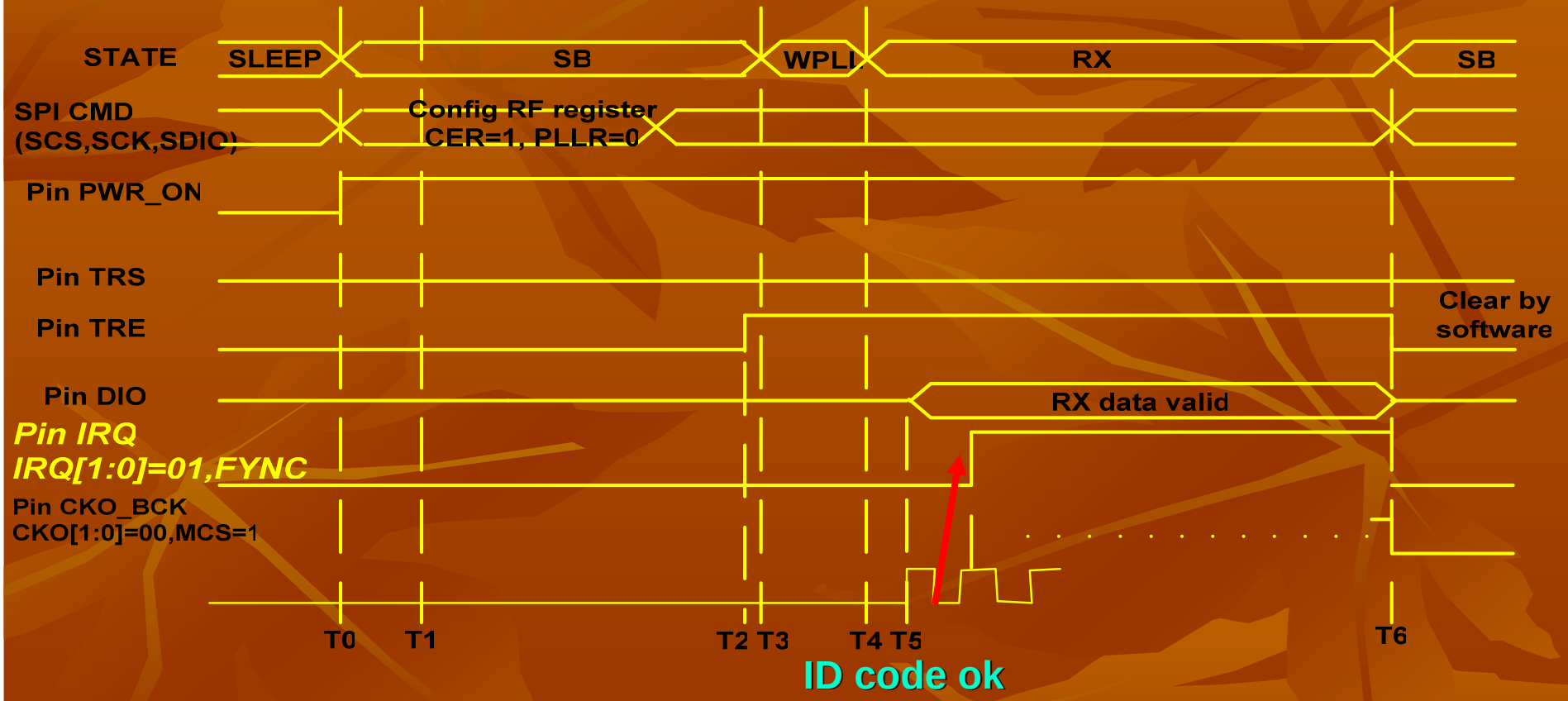
# Wireless system operation

## RX timing (Direct)



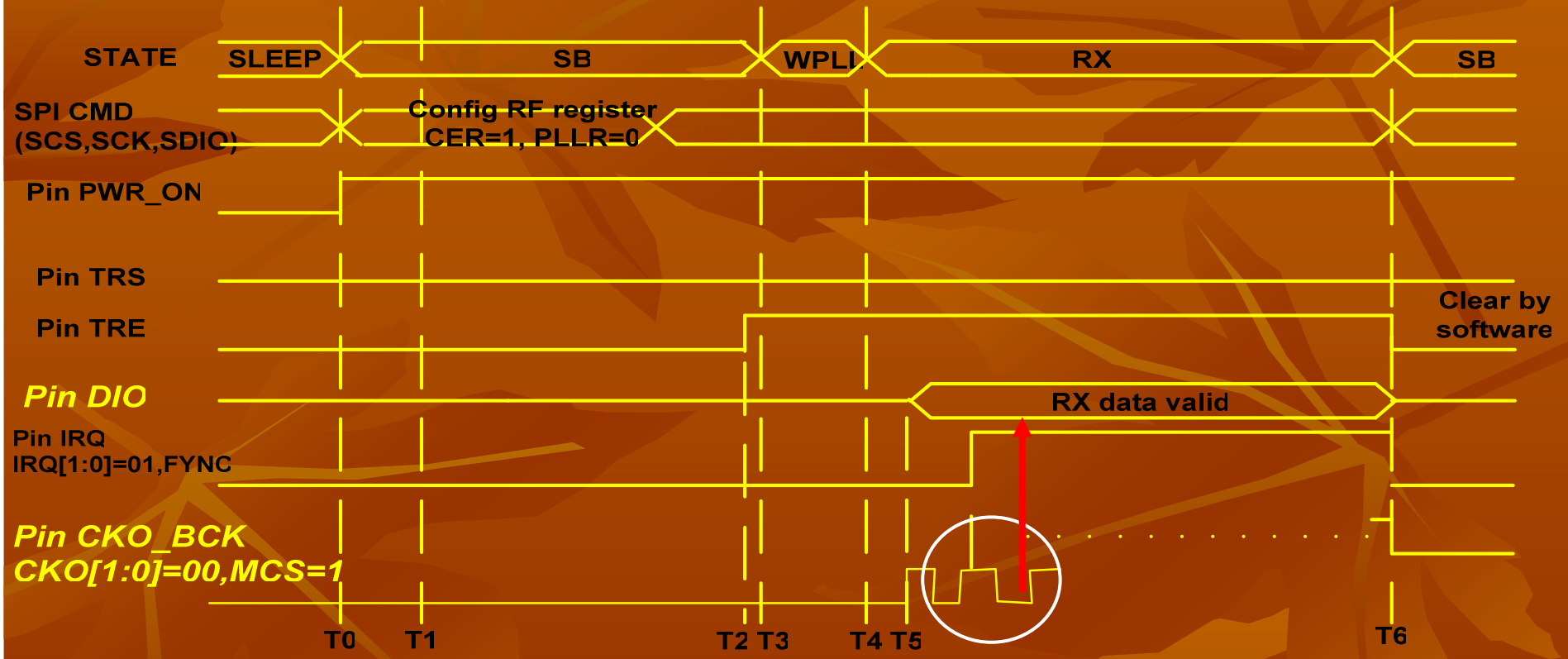
# Wireless system operation

## RX timing (Direct)



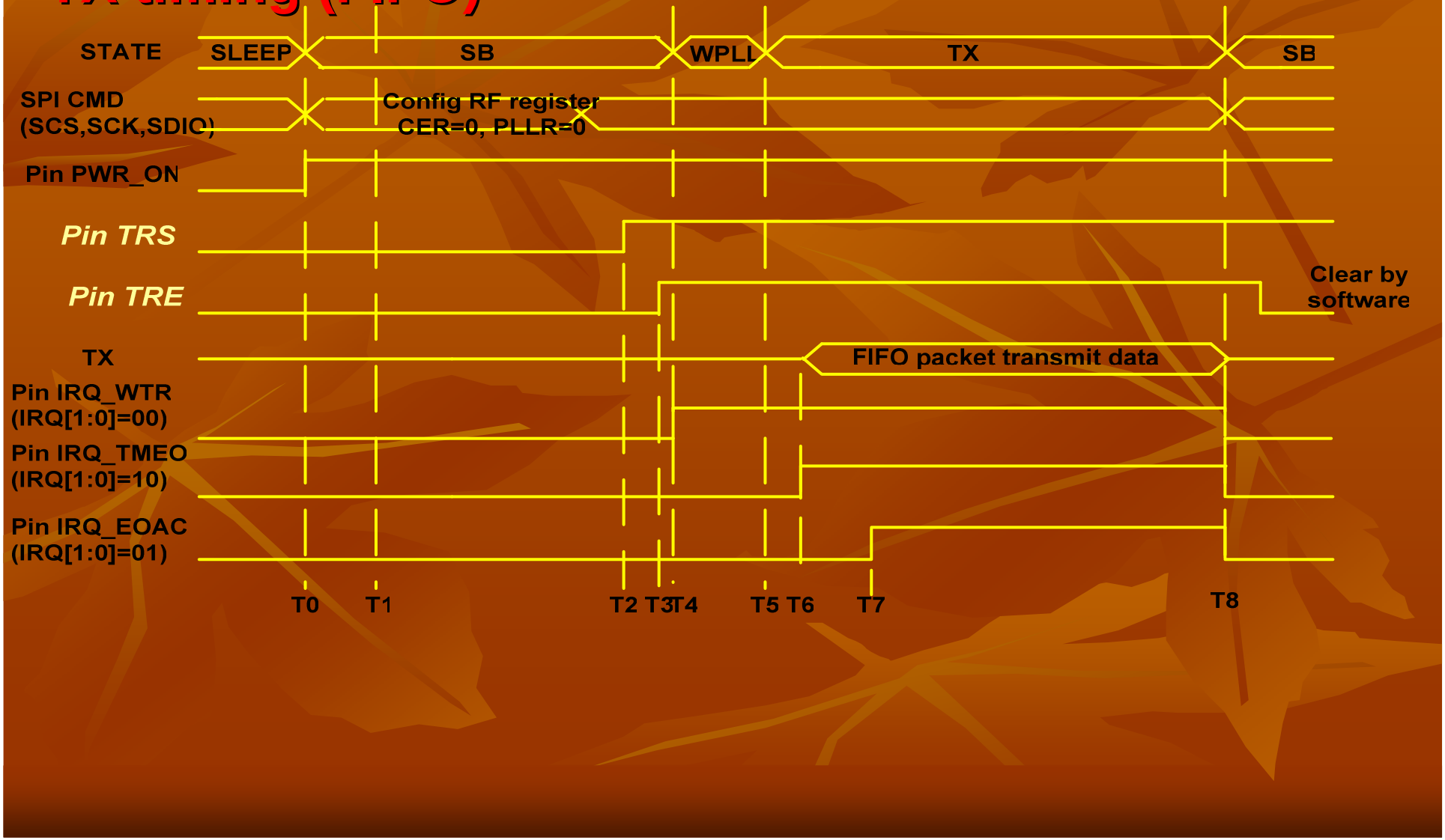
# Wireless system operation

## RX timing (Direct)



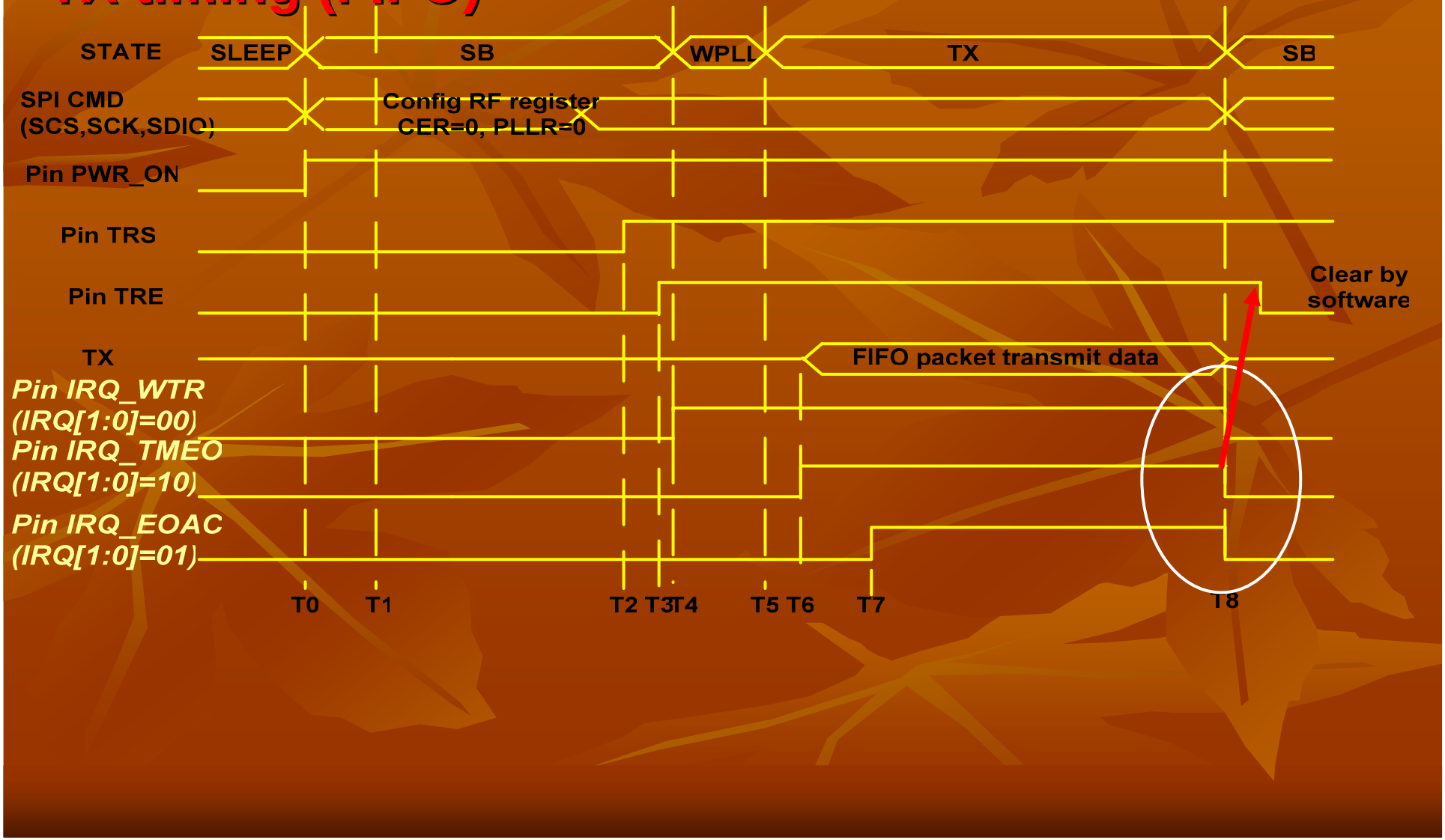
# Wireless system operation

## TX timing (FIFO)



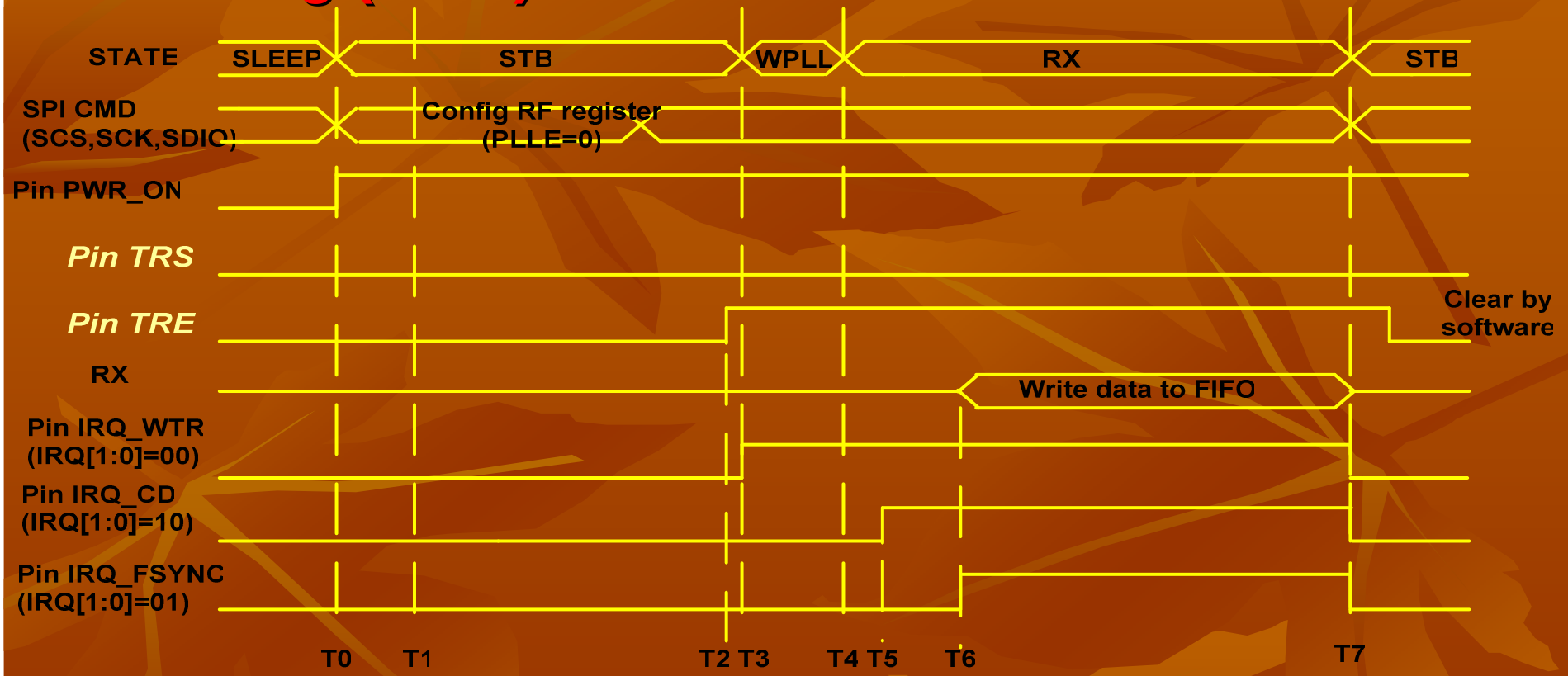
# Wireless system operation

## TX timing (FIFO)



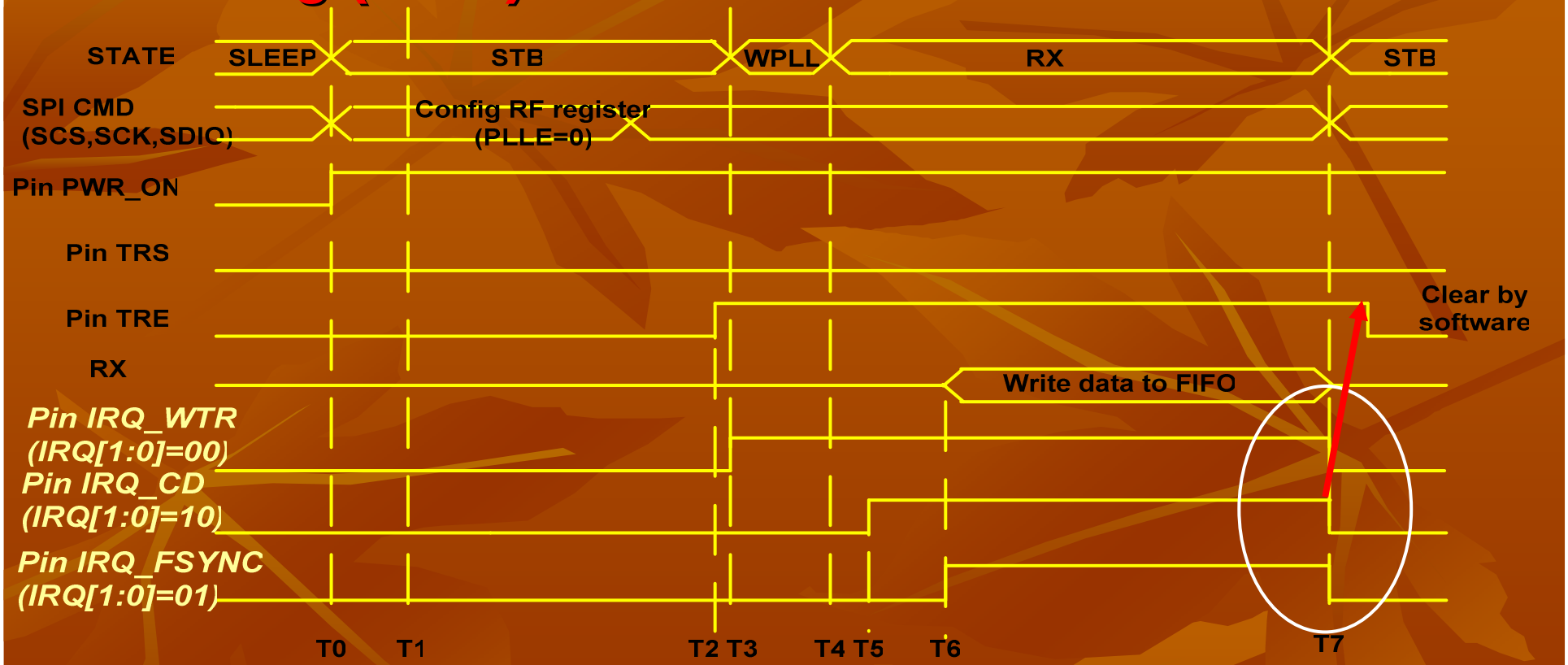
# Wireless system operation

## RX timing (FIFO)



# Wireless system operation

## RX timing (FIFO)



# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.ADC function
8.RTC function

# MCU I/O(FIFO)

Command
& FIFO

# MCU I/O(FIFO)


**SCS**
**SCK**
**SDIO**

# MCU I/O(FIFO)


**SCS**
**SCK**
**SDIO**

**Battery → REG_IN**
**all states except sleep**

**Battery → all VDD**
**all states**

# MCU I/O(FIFO)

Command & FIFO

SCS
SCK
SDIO

mode switch

PWR_ON
TRS
TRE

**Battery → REG_IN**
**all states except sleep**

**Battery → all VDD**
**all states**

# MCU I/O(FIFO)

Command & FIFO → SCS, SCK, SDIO

Mode switch → PWR_ON, TRS, TRE

Signal indication → IRQ

**Battery → REG_IN**
**all states except sleep**

**Battery → all VDD**
**all states**

**PWR_ON : Sleep → STB**
**TRS : TRX selection**
**TRE : SB → TRX**

# MCU I/O(FIFO)

Command & FIFO → SCS, SCK, SDIO

Mode switch → PWR_ON, TRS, TRE

Signal indication → IRQ

Battery → REG_IN
all states except sleep

Battery → all VDD
all states

PWR_ON : Sleep → STB
TRS : TRX selection
TRE : SB → TRX

Multi function I/O
IRQ{1,0]
00 : WPLL&TRX =1
01 : TX ID done / RX ID ok
10 : TX data out / CD
11 :  -- / EXT. RX ID ok

# MCU I/O(FIFO)

Command & FIFO → SCS, SCK, SDIO

Mode switch → PWR_ON, TRS, TRE

Signal indication → IRQ

Battery → REG_IN
all states except sleep

Battery → all VDD
all states

Total : 7 pins

PWR_ON : Sleep → STB
TRS : TRX selection
TRE : SB → TRX

Multi function I/O
IRQ{1,0]
00 : WPLL&TRX =1
01 : TX ID done / RX ID ok
10 : TX data out / CD
11 :  -- / EXT. RX ID ok

# MCU I/O(FIFO)

Command & FIFO

SCS
SCK
SDIO

Mode switch

PWR_ON
~~TRS~~
~~TRE~~

Control by register

Signal indication

IRQ

Battery → REG_IN
all states except sleep

Battery → all VDD
all states

Total : 5 pins

PWR_ON : Sleep → STB
TRS : TRX selection
TRE : SB → TRX

Multi function I/O
IRQ{1,0]
00 : WPLL&TRX =1
01 : TX ID done / RX ID ok
10 : TX data out / CD
11 :  -- / EXT. RX ID ok

# MCU I/O(FIFO)

Command & FIFO

SCS
SCK
SDIO

Mode switch

~~PWR_ON~~
~~TRS~~
~~TRE~~

Bypass REG

Signal indication

IRQ

Battery → REG_IN
all states except sleep

Battery → all VDD
all states

Total : 4 pins

PWR_ON : Sleep → STB
TRS : TRX selection
TRE : SB → TRX

Multi function I/O
IRQ{1,0]
00 : WPLL&TRX =1
01 : TX ID done / RX ID ok
10 : TX data out / CD
11 :  -- / EXT. RX ID ok

# MCU I/O (Direct)

**Command & FIFO**

- SCS
- SCK
- SDIO

**Mode switch**

- ~~PWR_ON~~
- ~~TRS~~
- ~~TRE~~

**Signal indication**

- IRQ
- CKO

Battery → REG_IN
all states except sleep

Battery → all VDD
all states

Total : 5 pins

PWR_ON : Sleep → STB
TRS : TRX selection
TRE : SB → TRX

Multi function I/O
IRQ{1,0]
00 : WPLL&TRX =1
01 : TX ID done / RX ID ok
10 : TX data out / CD
11 : -- / EXT. RX ID ok

TRX data latch clock

# MCU I/O (Direct)

**Command & FIFO**

- SCS
- SCK
- SDIO

**Mode switch**

- ~~PWR_ON~~
- ~~TRS~~
- ~~TRE~~

**Signal indication**

- IRQ
- ~~CKO~~

Battery → REG_IN
all states except sleep

Battery → all VDD
all states

Total : 4 pins

PWR_ON : Sleep → STB
TRS : TRX selection
TRE : SB → TRX

Multi function I/O
IRQ{1,0]
00 : WPLL&TRX =1
01 : TX ID done / RX ID ok
10 : TX data out / CD
11 : -- / EXT. RX ID ok

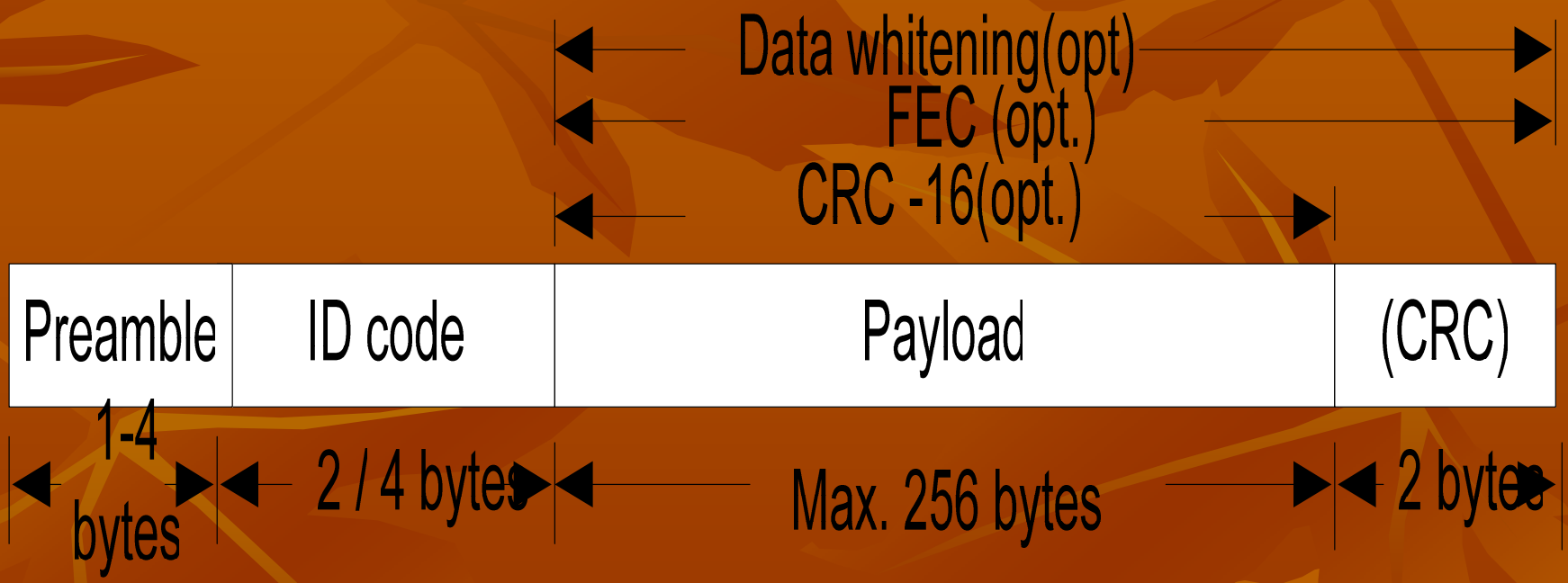
TRX data latch clock

# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.ADC function
8.RTC function

# Data mode

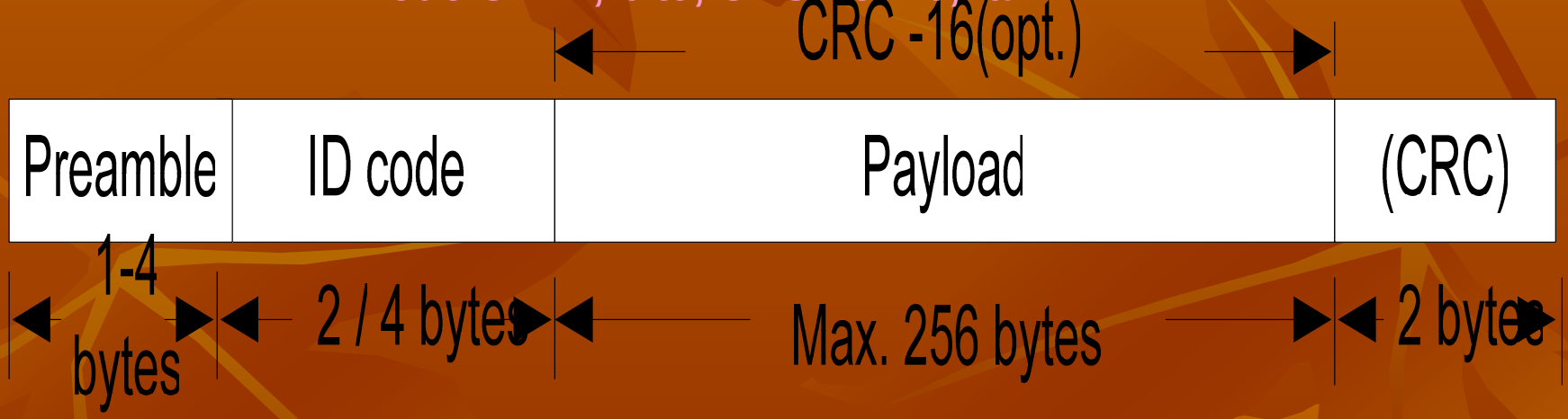
## Data format : FIFO mode



# Data mode

## Data format : FIFO mode

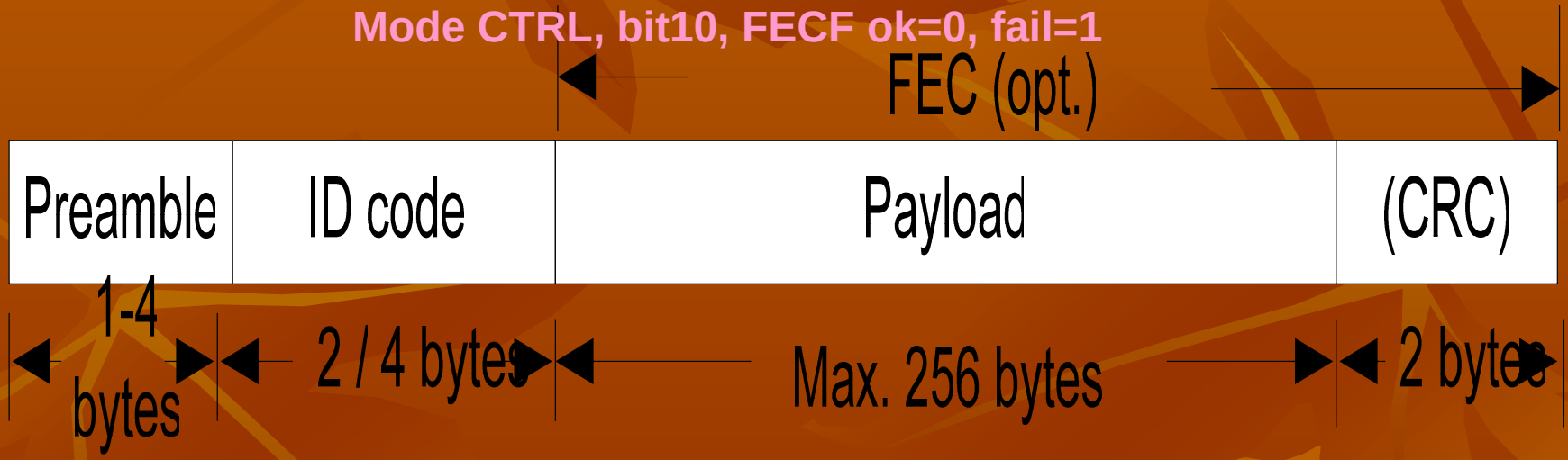
1. Enable CRC function : Code CTRL REG, bit3, CRCS
TX : Calculate CRC and add to tail
RX : Calculate CRC and compare CRC data
Mode CTRL, bit9, CRCF ok=0, fail=1



# Data mode

## Data format : FIFO mode

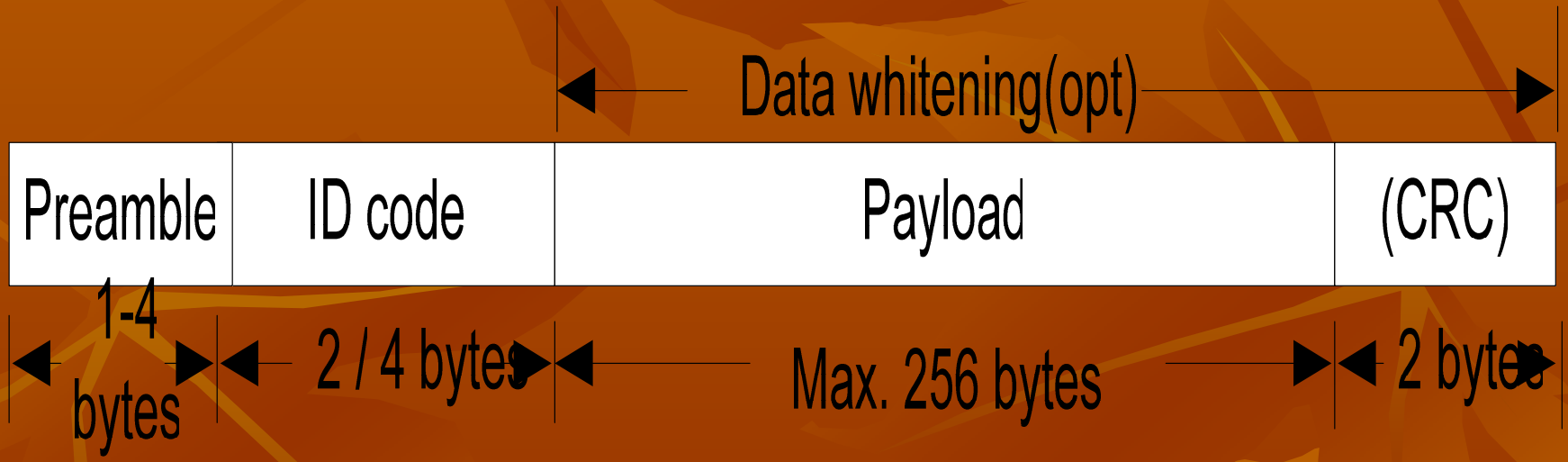
1. Enable FEC function : Code CTRL REG, bit4, FECS
TX : Transfer code from 4bit to 7bit
RX : Transfer code from 7bit to 4bit and correction
Mode CTRL, bit10, FECF ok=0, fail=1



# Data mode

## Data format : FIFO mode

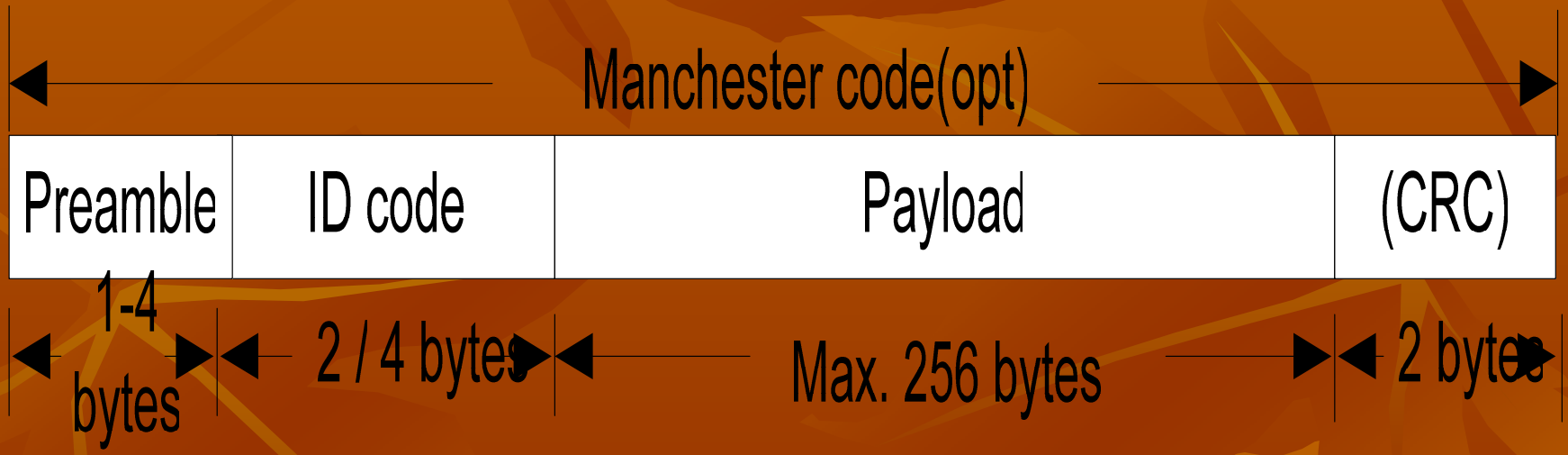
1. Enable whitening function : Code CTRL REG, bit5, WHTS
TX : Processing whitening function by whitening seed
RX : Processing whitening function by whitening seed



# Data mode

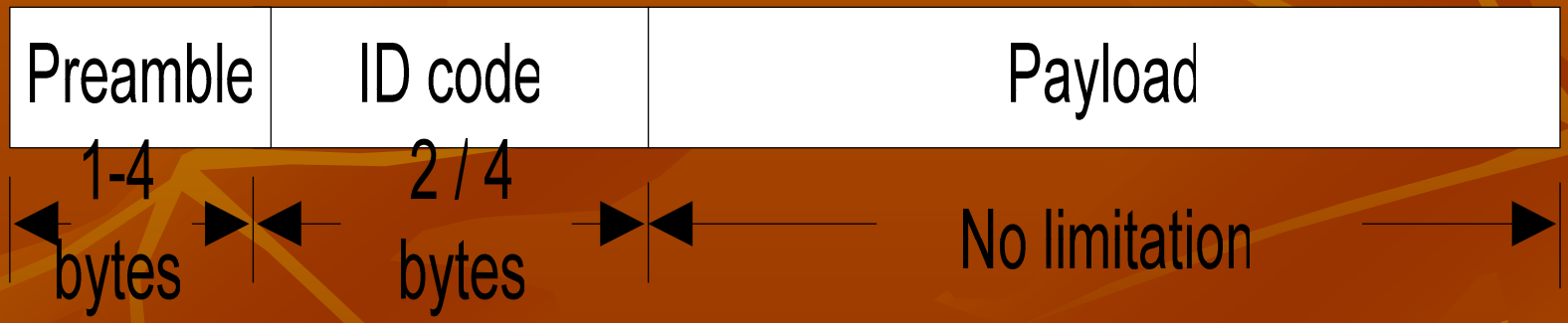
## Data format : FIFO mode

1. Enable Manchester function : Code CTRL REG, bit6, MCS
TX : Encode
RX : Decode



# Data mode

## Data format : Direct mode, by user define

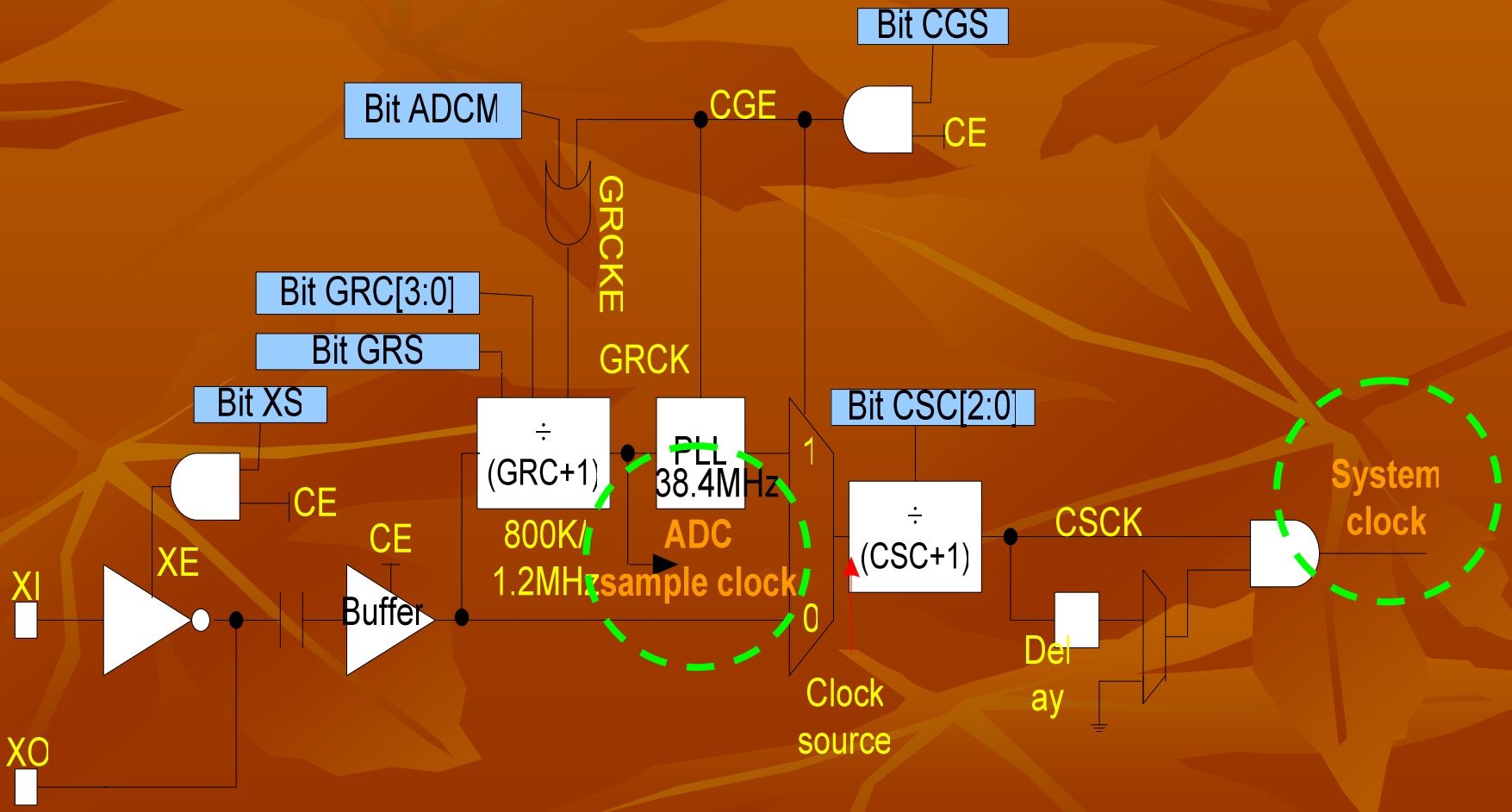


# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.ADC function
8.RTC function

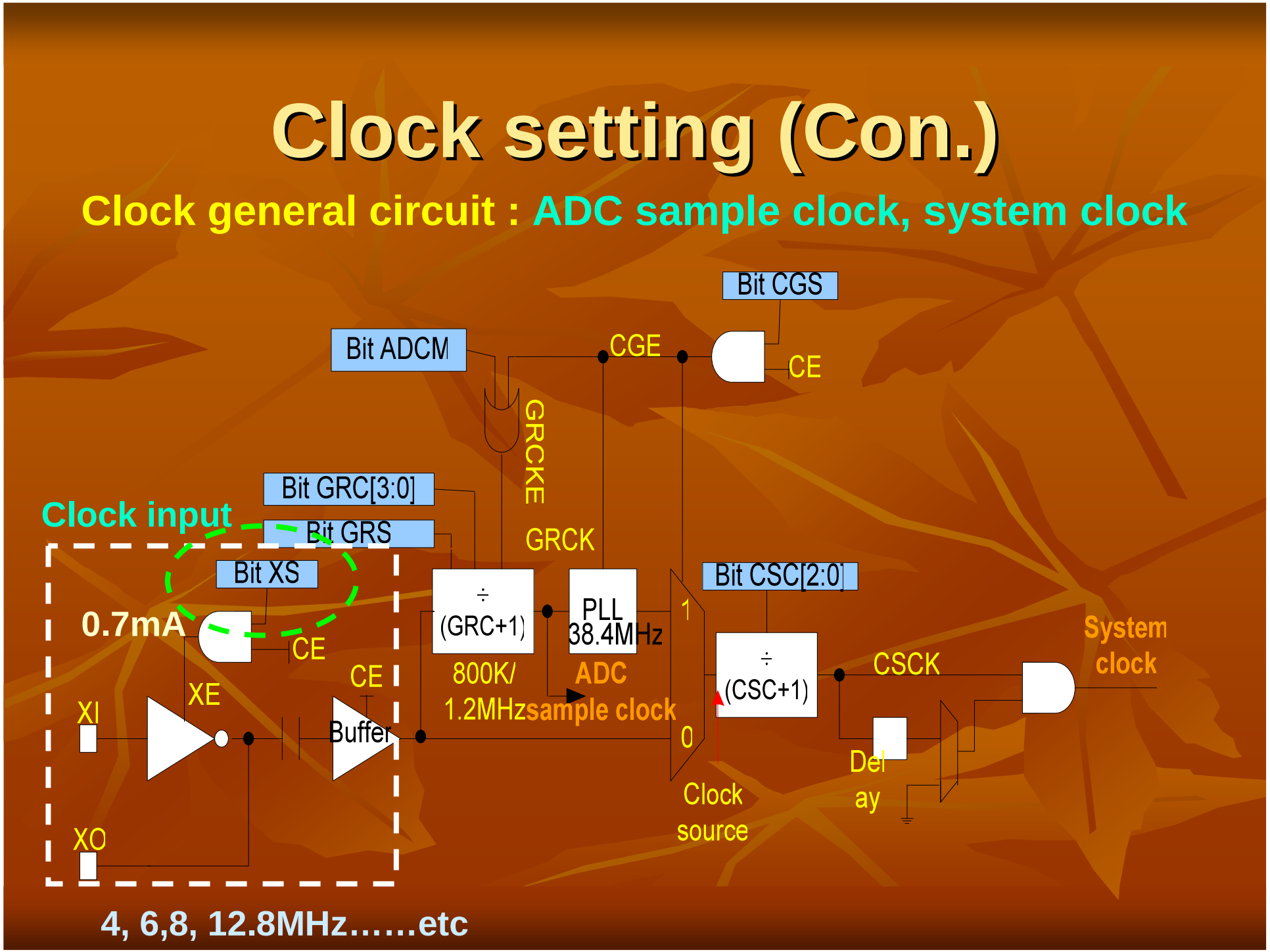
# Clock setting

## Clock general circuit : ADC sample clock, system clock



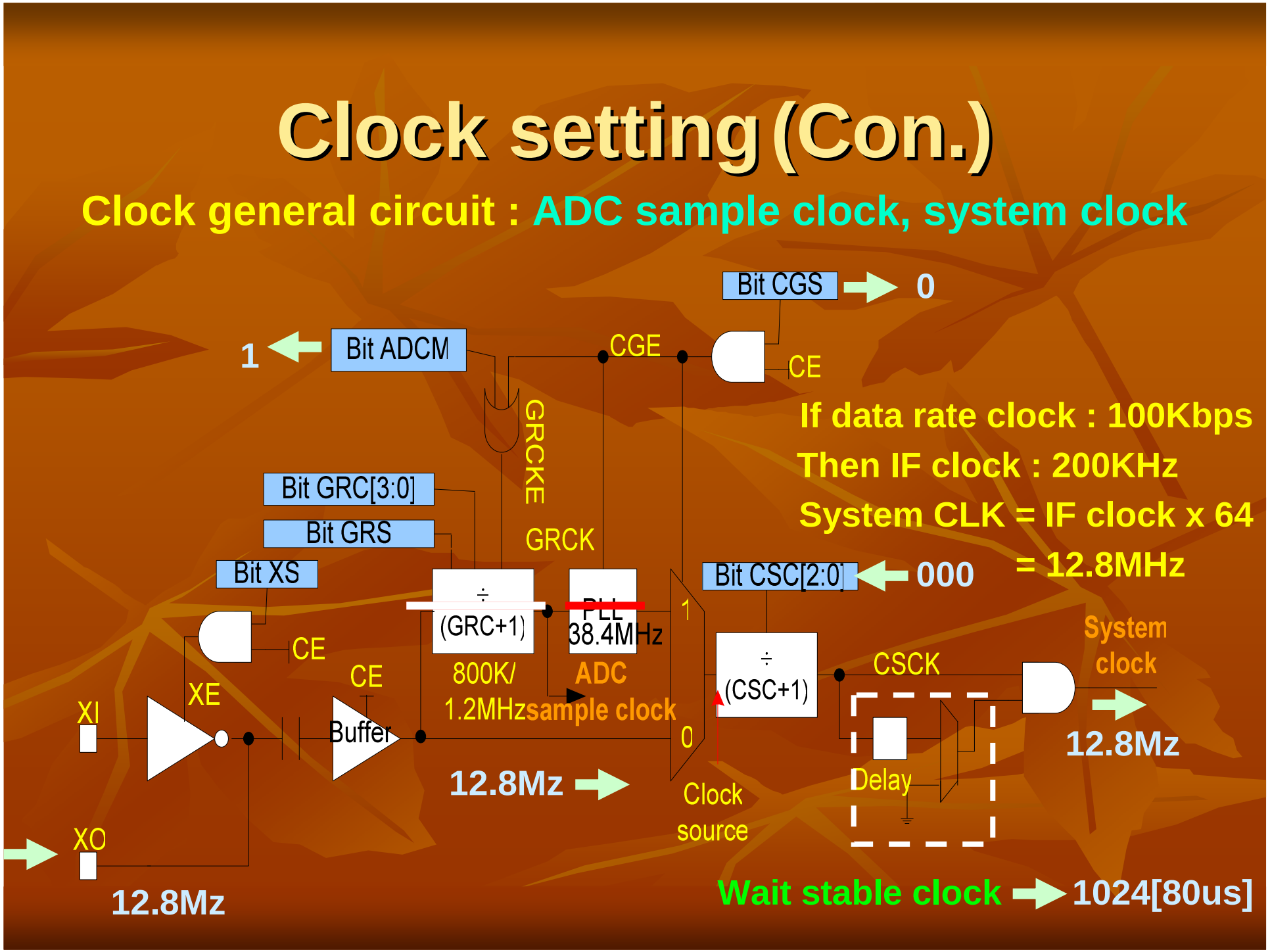
# Clock setting (Con.)

## Clock general circuit : ADC sample clock, system clock



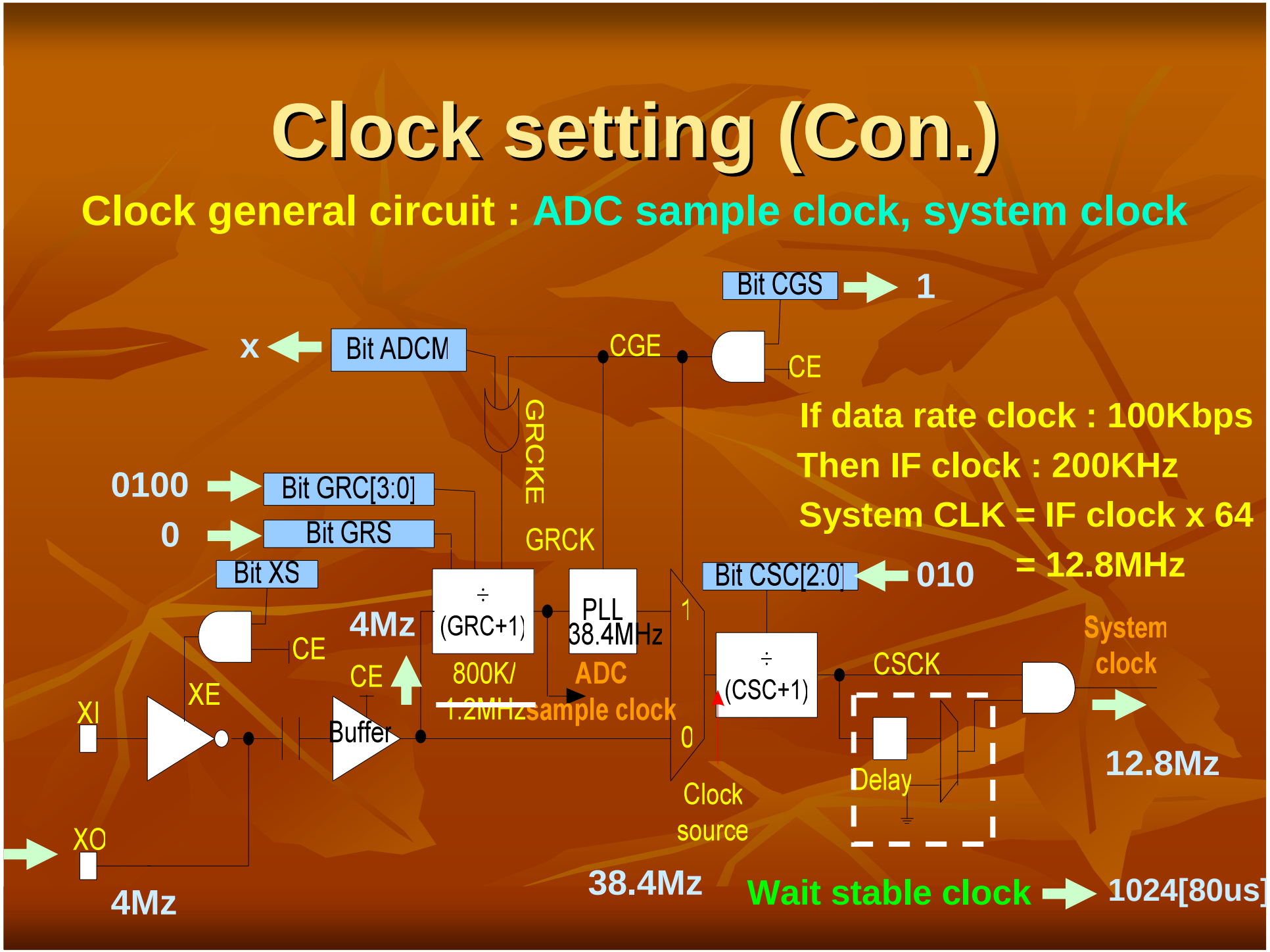
# Clock setting (Con.)

## Clock general circuit : ADC sample clock, system clock

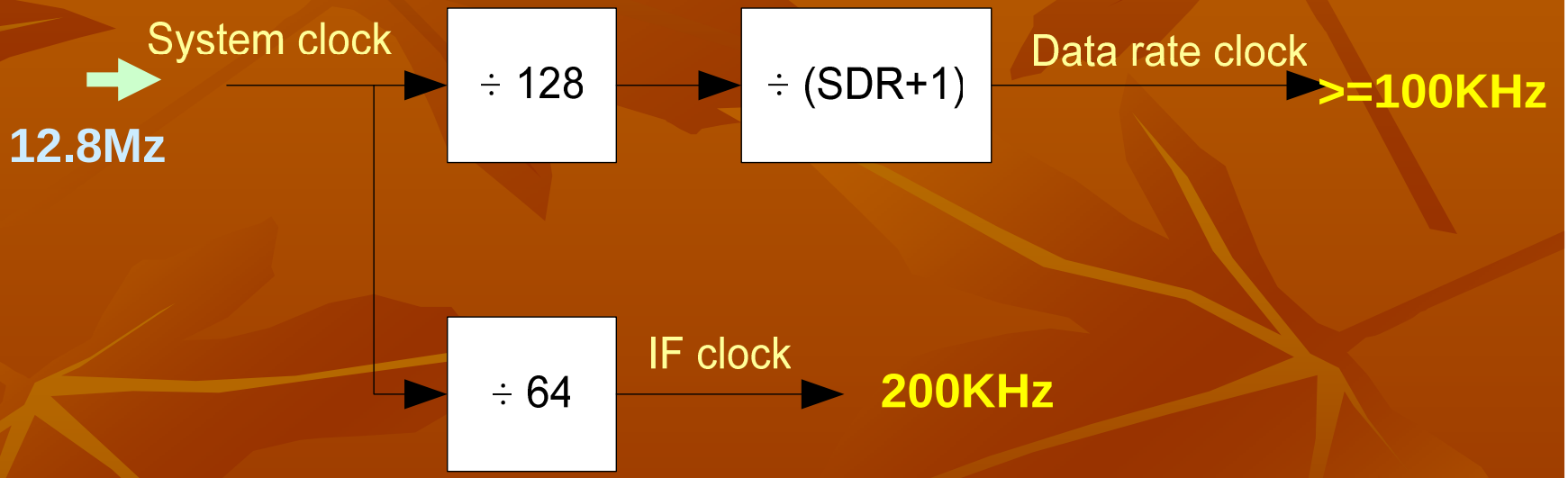


# Clock setting (Con.)

## Clock general circuit : ADC sample clock, system clock

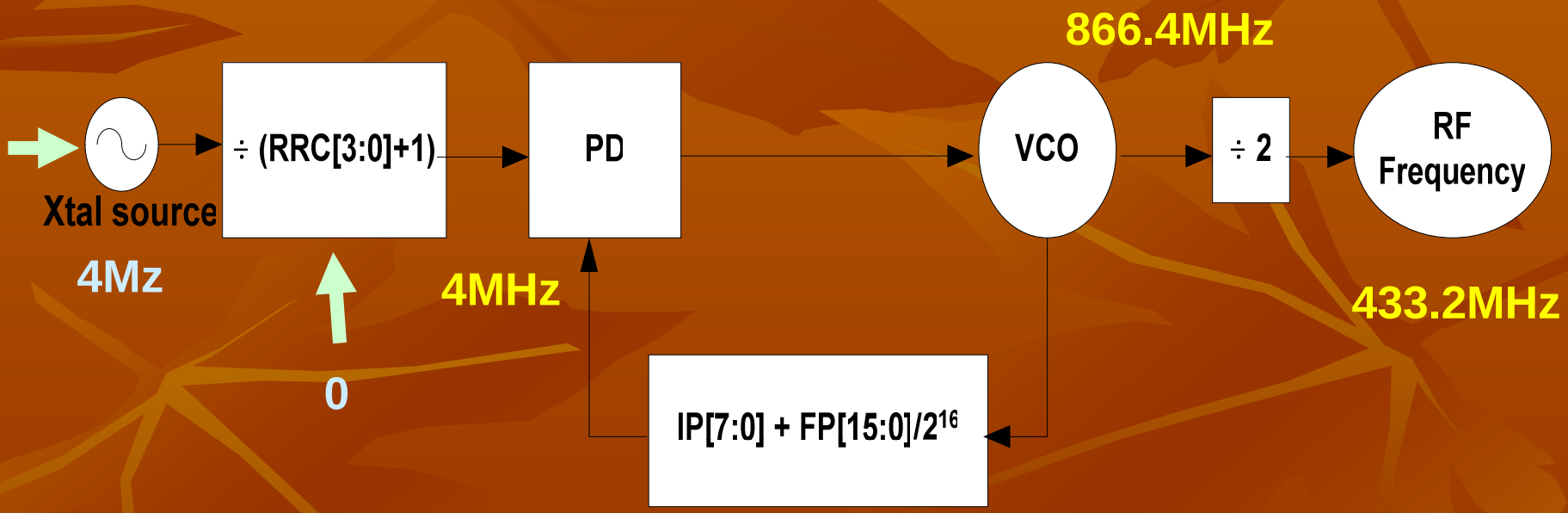


# Clock setting (Con.)



# Clock setting (Con.)

## RF Clock general circuit




866.4MHz / 4MHz = 216.6

Integer part

Frac. part

$IP[7:0] = 216 = 11011000_2$

$FP[15:0] = 0.6 \times 2^{16} = 39321.6 = 1001100110011001_2$

# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
5.Clock setting
6.Calibration
7.ADC function
8.RTC function

# Calibration

## IF Cal.

**1.STB mode**
**(XOSC and Band gap on)**

**2.Initial some clocks**
**(system, ADC, data rate, IF clk)**


**1.Set IF Cal mode -- auto**
**CAL. Reg_0Eh, bit4, MIFS**
**2.Enable IF Cal flag**
**MOD. Reg_0Fh, bit1, FBC**

**FBC=0, automatic clear**

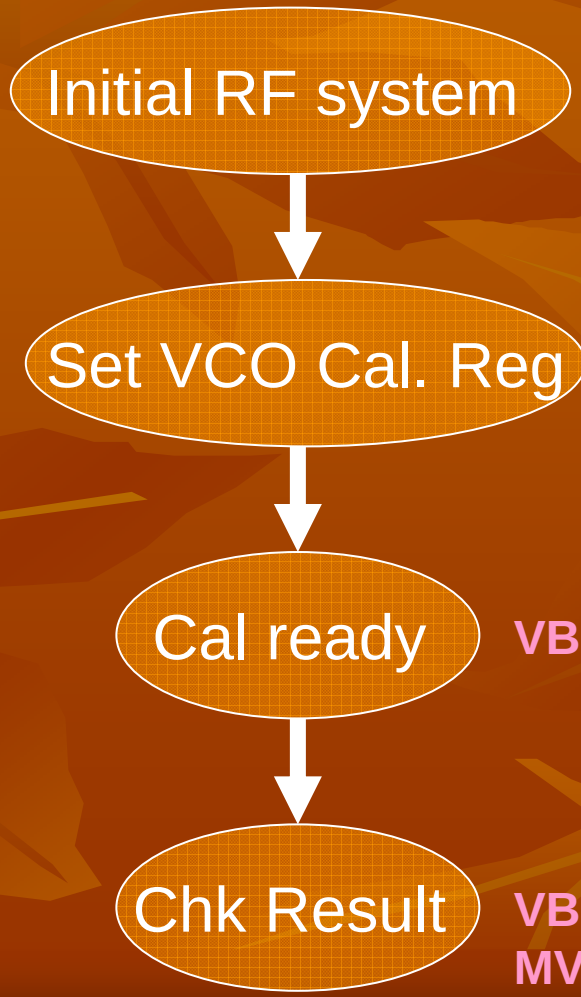
**FBCF=0, ok, CAL. Reg_0Eh, bit4, FBCF**
**MIF3-0, IF data, CAL. Reg_0Eh, bit3-0**

# Calibration

## VCO Cal.

**1.STB mode**
**(XOSC, Band gap and PLL on)**

**2.Initial some clocks**
**(system, ADC, data rate, IF and RF clk)**




**1.Set VT high and low range**
**2.Set VCO Cal mode -- auto**
**CAL. Reg_0Eh, bit8, MVBS**
**2.Enable VCO Cal flag**
**MOD. Reg_0Fh, bit2, VBC**

**VBC=0, automatic clear**

**VBCF=0, ok, CAL. Reg_0Eh, bit8**
**MVB2-0, IF data, CAL. Reg_0Eh, bit7-5**

# FW topic

0.RF feature
1.Wireless system
2.Wireless system operation
3.MCU I/O
4.Data format
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7.ADC function
8.RTC function

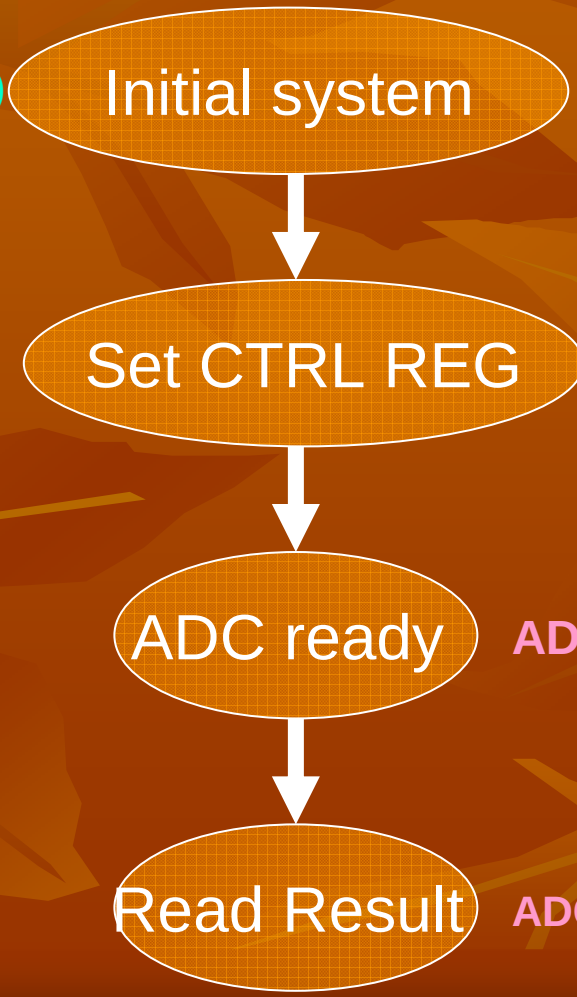
# ADC function

1.Build in 3-bit multi-channel ADC with 8-bit resolution .
2.It can convert a sample when enable ADC and run 20 ADC clocks after.
3.It provide three dedicated applications :
Temperature (need no external sensor)
RSSI (need no external sensor)
EXT. ADC input (need external sensor)

# ADC function

## Temperature measurement

1.STB mode
(XOSC and Band gap on)
2.Ready ADC clock




1.Set Temp. mode
ADC. Reg_0Ah, bit9, 8 = 0
2.Enable ADC enable flag
MOD. Reg_0Fh, bit0, ADCM = 1

ADCM = 0, automatic clear by HW

ADC7-0, ADC data, ADC. Reg_0Ah, bit7-0

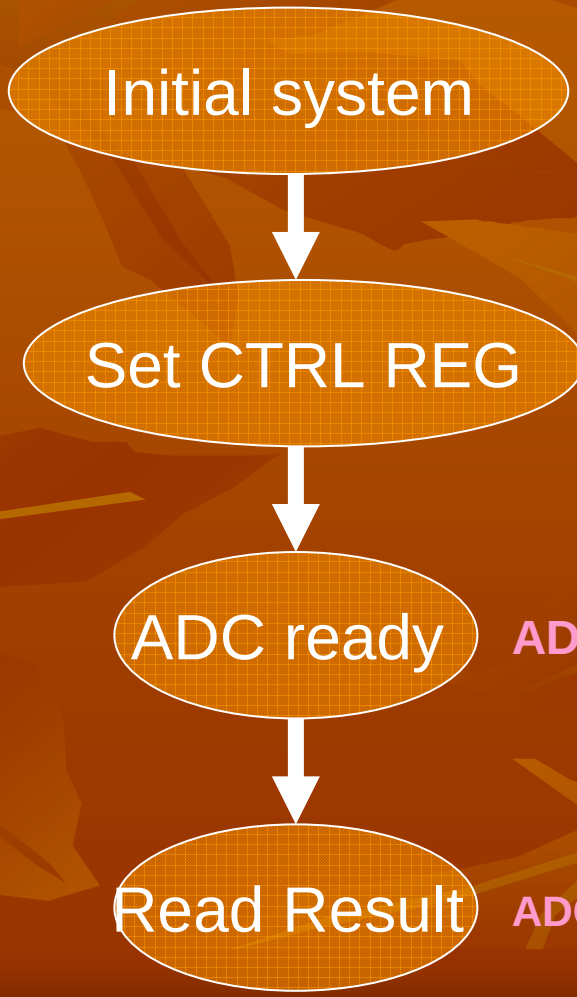
# ADC function

## RSSI measurement

Temp.

1.RX mode

2.Ready RF all clocks




1.Set RSSI. mode

ADC. Reg_0Ah, bit9, 8 = 0

2.Enable ADC enable flag

MOD. Reg_0Fh, bit0, ADCM = 1

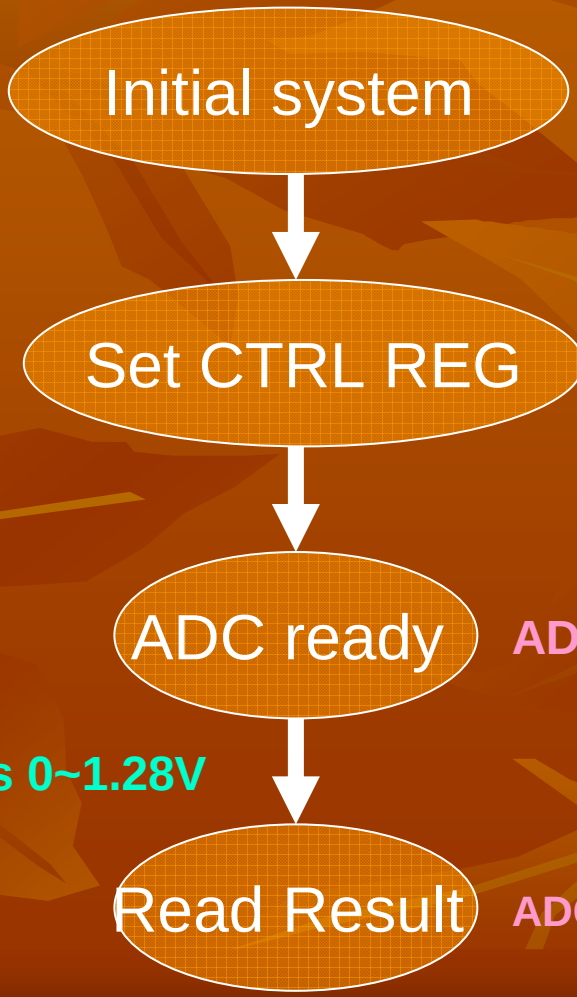
ADCM = 0, automatic clear by HW

ADC7-0, ADC data, ADC. Reg_0Ah, bit7-0

# ADC function

## EXT. ADC measurement

1.RX mode
2.Ready RF all clocks




RSSI

1.Set EXT. ADC. mode
ADC. Reg_0Ah, bit9=1, bit8 = 0
2.Enable ADC enable flag
MOD. Reg_0Fh, bit0, ADCM = 1

ADCM = 0, automatic clear by HW

Note : voltage range is 0~1.28V

ADC7-0, ADC data, ADC. Reg_0Ah, bit7-0

# FW topic

0.RF feature
1.Wireless system
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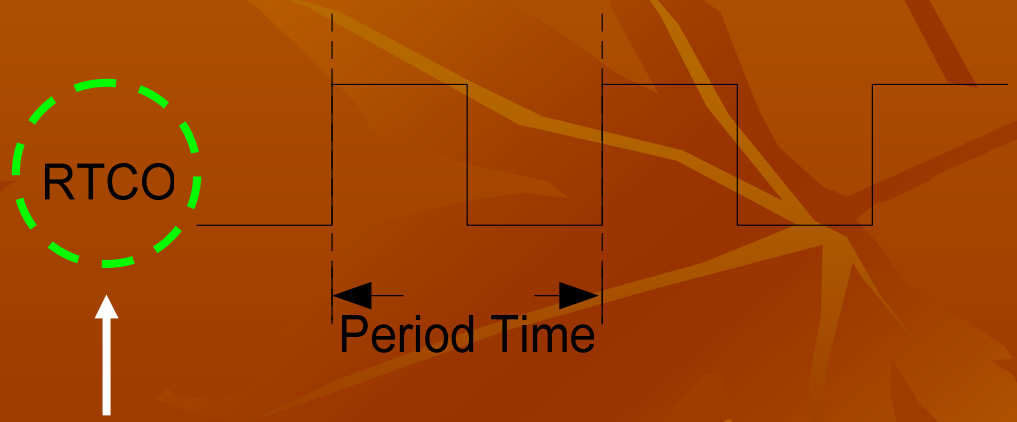
8.RTC function

# RTC function

1.Need a external 32.768KHz's crystal.
2.It can wakeup whole system when MCU and RF are sleep.
3.It provide four time scale for used.

| RTC[1:0] | Period Time |
|---|---|
| [00] | 250ms |
| [01] | 1s |
| [10] | 500ms |
| [11] | 2S |




Set RTCE and RTOE to 1.

# Thank you.