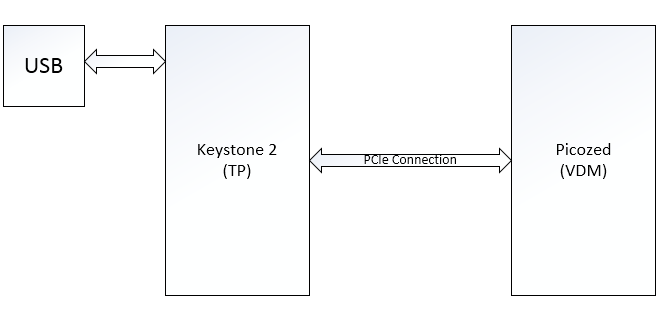
Acceptance Test Sheet for Threat Processor (MS09)

# **Test** **Description**:

* This test is intended to check the TP Processing for different threat scenarios.

# **Test** **Procedure**:

The working of the TP algorithm will be demonstrated through USB Playback. Synthetic data files stored in the USB will be loaded, sent to the VDM over PCIe after which the VDM will send the data back to the TP over same PCIe link after time correlation and will be processed by the TP. The results will be saved in a text file for observation.



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# **Revision** **History**

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Name** | **Revision** | **Comment** |
| 8-05-2017 | Yaseen Athar | Rev.1.1 | Draft |
| 10-05-2017 | Yaseen Athar | Rev.1.1 | Draft |

# **Test Cases and Parameters**

# Emitter Type Identifications

The test scenarios described below aim to demonstrate the emitter type identification features of the TP algorithm.

# PW Types

## PW: Fixed and Agile



Characterization according to percentage deviation boundary

1. F=10GHz, PRI=100us, AOA=45, PW=200ns, ΔPW=5% (10ns)

To be characterized as **fixed** PW

1. F=10GHz, PRI=100us, AOA=45, PW=200ns, ΔPW=15% (30ns)

To be characterized as **agile** PW

Characterization according to absolute deviation boundary

1. F=10GHz, PRI=300us, AOA=45, PW=100us, ΔPW=0.3% (300ns)

To be characterized as **agile** PW

# Frequency Types

## Freq Type: Fixed and Agile



Characterization according to percentage deviation boundary

1. F=2.5GHz, PRI=100us, AOA=45, PW=200ns, ΔF=0.2% (5MHz)

To be characterized as **fixed** Freq

1. F=2.5GHz, PRI=100us, AOA=45, PW=200ns, ΔF=0.3% (7.5MHz)

To be characterized as **agile** Freq

Characterization according to absolute deviation boundary

1. F=6GHz, PRI=100us, AOA=45, PW=200ns, ΔF=0.2% (12MHz)

To be characterized as **agile** Freq

## Freq Type: Sweep

Will be incorporated at a later time, not to be demonstrated in the current Demo

## Freq Type: Switch

* Switching in sequence between N discrete values.
* The allowed deviation for this is the same as the deviation for fixed frequency (0.25% or 8MHz)
* Complex and agile ‘deviations’ apply to individual spots.
* If more than 16 spots present within the reporting time (200ms), earlier spots will be overwritten by later ones.

1. PRI=10us, AOA=45, PW=200ns, N=16, Inst. BW ≤1GHz, Per level deviations within ‘fixed’ limits

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | F Spots (GHz) | ΔF | Dwell Time |
| 1 | 10.25 | 0.02% (~2MHz) | 100 us |
| 2 | 10.10 | 0.01% (~1MHz) | 120 us |
| 3 | 11.00 | 0.03% (~3MHz) | 150us |
| 4 | 10.75 | 0.05% (~5MHz) | 110 us |
| 5 | 10.55 | 0.04% (~4MHz) | 100 us |
| 6 | 10.90 | 0.03% (~3MHz) | 130 us |
| 7 | 10.60 | 0.01% (~1MHz) | 170 us |
| 8 | 10.20 | 0.02% (~2MHz) | 120 us |
| 9 | 10.95 | 0.01% (~1MHz) | 150 us |
| 10 | 10.00 | 0.03% (~3MHz) | 110 us |
| 11 | 10.05 | 0.02% (~2MHz) | 150 us |
| 12 | 10.15 | 0.01% (~1MHz) | 110 us |
| 13 | 10.85 | 0.03% (~3MHz) | 100 us |
| 14 | 10.65 | 0.01% (~1MHz) | 130 us |
| 15 | 10.70 | 0.04% (~4MHz) | 180 us |
| 16 | 10.80 | 0.05% (~5.5MHz) | 150 us |

1. PRI=10us, AOA=45, PW=200ns, N=16, Inst. BW ≤1GHz, Per level deviations exceed ‘fixed’ limits for some levels

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | F Spots (GHz) | ΔF | Dwell Time |
| 1 | 10.25 | 0.02% (~2MHz) | 100 us |
| 2 | 10.10 | 0.01% (~1MHz) | 120 us |
| 3 | 11.00 | 0.03% (~3MHz) | 150 us |
| 4 | 10.75 | 0.25% (~27MHz) | 110 us |
| 5 | 10.55 | 0.04% (~4MHz) | 100 us |
| 6 | 10.90 | 0.03% (~3MHz) | 130 us |
| 7 | 10.60 | 0.01% (~1MHz) | 170 us |
| 8 | 10.20 | 0.3% (~30MHz) | 120 us |
| 9 | 10.95 | 0.01% (~1MHz) | 150 us |
| 10 | 10.00 | 0.03% (~3MHz) | 110 us |
| 11 | 10.05 | 0.02% (~2MHz) | 150 us |
| 12 | 10.15 | 0.01% (~1MHz) | 110 us |
| 13 | 10.85 | 0.03% (~3MHz) | 100 us |
| 14 | 10.65 | 0.01% (~1MHz) | 130 us |
| 15 | 10.70 | 0.04% (~4MHz) | 180 us |
| 16 | 10.80 | 0.10% (~11MHz) | 150 us |

1. PRI=10us, AOA=45, PW=200ns, N=18, Inst. BW ≤ 1GHz,deviations within limits

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | F Spots (GHz) | ΔF | Dwell Time |
| 1 | 10.25 | 0.02% (~2MHz) | 100 us |
| 2 | 10.10 | 0.01% (~1MHz) | 120 us |
| 3 | 11.00 | 0.03% (~3MHz) | 150 us |
| 4 | 10.75 | 0.05% (~5MHz) | 110 us |
| 5 | 10.55 | 0.04% (~4MHz) | 100 us |
| 6 | 10.90 | 0.03% (~3MHz) | 130 us |
| 7 | 10.60 | 0.01% (~1MHz) | 170 us |
| 8 | 10.20 | 0.02% (~2MHz) | 120 us |
| 9 | 10.95 | 0.01% (~1MHz) | 150 us |
| 10 | 10.00 | 0.03% (~3MHz) | 110 us |
| 11 | 10.30 | 0.05% (~5MHZ) | 180 us |
| 12 | 10.05 | 0.02% (~2MHz) | 150 us |
| 13 | 10.15 | 0.01% (~1MHz) | 110 us |
| 14 | 10.85 | 0.03% (~3MHz) | 100 us |
| 15 | 10.65 | 0.01% (~1MHz) | 130 us |
| 16 | 10.70 | 0.04% (~4MHz) | 180 us |
| 17 | 10.80 | 0.05% (~5.5MHz) | 150 us |
| 18 | 10.50 | 0.04% (~4MHz) | 120 us |

1. PRI=10us, AOA=45, PW=200ns, N=16, Inst. BW ≥ 1GHz, deviations within limits

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | F Spots | ΔF | Dwell Time |
| 1 | 10.25 | 0.02% (~2MHz) | 100 us |
| 2 | 10.10 | 0.01% (~1MHz) | 120 us |
| 3 | 11.00 | 0.03% (~3MHz) | 150 us |
| 4 | 10.75 | 0.05% (~5MHz) | 110 us |
| 5 | 10.55 | 0.04% (~4MHz) | 100 us |
| 6 | 10.90 | 0.03% (~3MHz) | 130 us |
| 7 | 10.60 | 0.01% (~1MHz) | 170 us |
| 8 | 10.20 | 0.02% (~2MHz) | 120 us |
| 9 | 11.10 | 0.01% (~1MHz) | 150 us |
| 10 | 10.00 | 0.03% (~3MHz) | 110 us |
| 11 | 10.05 | 0.02% (~2MHz) | 150 us |
| 12 | 10.15 | 0.01% (~1MHz) | 110 us |
| 13 | 11.15 | 0.03% (~3MHz) | 100 us |
| 14 | 10.65 | 0.01% (~1MHz) | 130 us |
| 15 | 10.70 | 0.04% (~4MHz) | 180 us |
| 16 | 10.80 | 0.05% (~5.5MHz) | 150 us |

## Freq Type: Step

* Switching in **fixed** sequence between N discrete values 2 ≤N ≤16.
* Max std. dev. of every Freq below lowest

dev.< 0.25% or dev.< 8MHz

* For N>16 Agile and Complex limits apply

1. PRI=10us, AOA=45, PW=200ns, N=16, Inst. BW ≤ 1GHz

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.88 | 0.02% (~3MHz) |
| 2 | 15.00 | 0.01% (~1.5MHz) |
| 3 | 14.64 | 0.04% (~6MHz) |
| 4 | 14.12 | 0.03% (~4MHz) |
| 5 | 14.74 | 0.02% (~3MHz) |
| 6 | 14.82 | 0.01% (~1.5MHz) |
| 7 | 14.62 | 0.02% (~3MHz) |
| 8 | 14.66 | 0.01% (~1.5MHz) |
| 9 | 14.68 | 0.03% (~4.5MHz) |
| 10 | 14.10 | 0.02% (~3MHz) |
| 11 | 14.04 | 0.04% (~6MHz) |
| 12 | 14.30 | 0.03% (~4MHz) |
| 13 | 14.20 | 0.01% (~1.5MHz) |
| 14 | 14.58 | 0.02% (~3MHz) |
| 15 | 14.54 | 0.04%(~6MHz) |
| 16 | 14.32 | 0.03%(~4MHz) |

1. PRI=10us, AOA=45, PW=200ns, N=16,Inst. BW ≥ 1GHz

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.88 | 0.02% (~3MHz) |
| 2 | 15.00 | 0.01% (~1.5MHz) |
| 3 | 14.64 | 0.04% (~6MHz) |
| 4 | 14.12 | 0.03% (~4MHz) |
| 5 | 14.74 | 0.02% (~3MHz) |
| 6 | 14.82 | 0.01% (~1.5MHz) |
| 7 | 14.62 | 0.02% (~3MHz) |
| 8 | 14.66 | 0.01% (~1.5MHz) |
| 9 | 14.68 | 0.03% (~4.5MHz) |
| 10 | 14.10 | 0.02% (~3MHz) |
| 11 | 14.04 | 0.04% (~6MHz) |
| 12 | 14.30 | 0.03% (~4MHz) |
| 13 | 14.20 | 0.01% (~1.5MHz) |
| 14 | 15.30 | 0.02% (~3MHz) |
| 15 | 14.54 | 0.04%(~6MHz) |
| 16 | 14.32 | 0.03%(~4MHz) |

1. PRI=10us, AOA=45, PW=200ns, N=8,Inst. BW ≤1GHz, Deviations exceed limit for some levels

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.62 | 0.02% (~3MHz) |
| 2 | 14.66 | 0.01% (~1.5MHz) |
| 3 | 14.68 | 0.03% (~4.5MHz) |
| 4 | 14.10 | 0.02% (~3MHz) |
| 5 | 14.04 | 0.30% (~42MHz) |
| 6 | 14.30 | 0.03% (~4MHz) |
| 7 | 14.20 | 0.40% (~57MHz) |
| 8 | 14.58 | 0.02% (~3MHz) |

1. PRI=10us, AOA=45, PW=200ns, N=18, Inst. BW ≤1GHz, exceeds max N level limit

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.88 | 0.02% (~3MHz) |
| 2 | 15.00 | 0.01% (~1.5MHz) |
| 3 | 14.64 | 0.04% (~6MHz) |
| 4 | 14.12 | 0.03% (~4MHz) |
| 5 | 14.74 | 0.02% (~3MHz) |
| 6 | 14.82 | 0.01% (~1.5MHz) |
| 7 | 14.62 | 0.02% (~3MHz) |
| 8 | 14.66 | 0.01% (~1.5MHz) |
| 9 | 14.68 | 0.03% (~4.5MHz) |
| 10 | 14.10 | 0.02% (~3MHz) |
| 11 | 14.04 | 0.04% (~6MHz) |
| 12 | 14.30 | 0.03% (~4MHz) |
| 13 | 14.20 | 0.01% (~1.5MHz) |
| 14 | 14.78 | 0.02% (~3MHz) |
| 15 | 14.54 | 0.04% (~6MHz) |
| 16 | 14.32 | 0.03% (~4MHz) |
| 17 | 14.76 | 0.02% (~3MHz) |
| 18 | 14.70 | 0.01% (~1.5MHz) |

1. (\*New) PRI=55us, AOA=305, PW=450ns, N=7, 2x values beyond 1 GHz Bandwidth

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 4.22 | 0.05% (~2MHz) |
| 2 | 4.75 | 0.15% (~7MHz) |
| 3 | 4.05 | 0.10% (~4MHz) |
| 4 | 4.90 | 0.15% (~7MHz) |
| 5 | 5.10 | 0.05% (~2.5MHz) |
| 6 | 4.15 | 0.15% (~6.2MHz) |
| 7 | 3.80 | 0.10% (~3.8MHz) |

1. (\*New) PRI=45us, AOA=170, PW=300ns, N=7, 3x values beyond 1 GHz Bandwidth

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 4.22 | 0.05% (~2MHz) |
| 2 | 5.20 | 0.10% (~5.2MHz) |
| 3 | 4.05 | 0.10% (~4MHz) |
| 4 | 4.90 | 0.15% (~7MHz) |
| 5 | 5.10 | 0.05% (~2.5MHz) |
| 6 | 4.15 | 0.15% (~6.2MHz) |
| 7 | 3.80 | 0.10% (~3.8MHz) |

1. (\*New) PRI=60us, AOA=25, PW=500ns, N=12, 2 consecutive values with large deviations

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 9.30 | 0.02% (~2MHz) |
| 2 | 8.75 | 0.01% (~1MHz) |
| 3 | 9.40 | 0.04% (~4MHz) |
| 4 | 9.45 | 0.03% (~3MHz) |
| 5 | 8.50 | 0.25% (~21MHz) |
| 6 | 9.15 | 0.20% (~18MHz) |
| 7 | 8.70 | 0.02% (~1.8MHz) |
| 8 | 8.95 | 0.01% (~1MHz) |
| 9 | 9.25 | 0.03% (~2.8MHz) |
| 10 | 9.00 | 0.02% (~1.8MHz) |
| 11 | 8.60 | 0.04% (~3.5MHz) |
| 12 | 9.05 | 0.03% (~2.7MHz) |

## Freq Type: Jump

* Switching in **random** sequence between N discrete values 2 ≤N ≤16.
* Max std. dev. of every Freq below lowest

dev. < 0.25% or dev. < 8MHz

* For N>16 Agile and Complex limits apply

1. PRI=10us, AOA=45, PW=200ns, N=16, Inst. BW ≤ 1GHz

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.88 | 0.02% (~3MHz) |
| 2 | 15.00 | 0.01% (~1.5MHz) |
| 3 | 14.64 | 0.04% (~6MHz) |
| 4 | 14.12 | 0.03% (~4MHz) |
| 5 | 14.74 | 0.02% (~3MHz) |
| 6 | 14.82 | 0.01% (~1.5MHz) |
| 7 | 14.62 | 0.02% (~3MHz) |
| 8 | 14.66 | 0.01% (~1.5MHz) |
| 9 | 14.68 | 0.03% (~4.5MHz) |
| 10 | 14.10 | 0.02% (~3MHz) |
| 11 | 14.04 | 0.04% (~6MHz) |
| 12 | 14.30 | 0.03% (~4MHz) |
| 13 | 14.20 | 0.01% (~1.5MHz) |
| 14 | 14.58 | 0.02% (~3MHz) |
| 15 | 14.54 | 0.04% (~6MHz) |
| 16 | 14.32 | 0.03% (~4MHz) |

1. PRI=10us, AOA=45, PW=200ns, N=16, Inst. BW ≥ 1GHz

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.88 | 0.02% (~3MHz) |
| 2 | 15.00 | 0.01% (~1.5MHz) |
| 3 | 14.64 | 0.04% (~6MHz) |
| 4 | 14.12 | 0.03% (~4MHz) |
| 5 | 14.74 | 0.02% (~3MHz) |
| 6 | 14.82 | 0.01% (~1.5MHz) |
| 7 | 14.62 | 0.02% (~3MHz) |
| 8 | 14.66 | 0.01% (~1.5MHz) |
| 9 | 14.68 | 0.03% (~4.5MHz) |
| 10 | 14.10 | 0.02% (~3MHz) |
| 11 | 14.04 | 0.04% (~6MHz) |
| 12 | 14.30 | 0.03% (~4MHz) |
| 13 | 14.20 | 0.01% (~1.5MHz) |
| 14 | 15.30 | 0.02% (~3MHz) |
| 15 | 14.54 | 0.04% (~6MHz) |
| 16 | 14.32 | 0.03% (~4MHz) |

1. PRI=10us, AOA=45, PW=200ns, N=8, Inst. BW ≤1GHz, Deviations exceed limit for some levels

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.62 | 0.02% (~3MHz) |
| 2 | 14.66 | 0.01% (~1.5MHz) |
| 3 | 14.68 | 0.03% (~4.5MHz) |
| 4 | 14.10 | 0.02% (~3MHz) |
| 5 | 14.04 | 0.30% (~42MHz) |
| 6 | 14.30 | 0.03% (~4MHz) |
| 7 | 14.20 | 0.40% (~57MHz) |
| 8 | 14.58 | 0.02% (~3MHz) |

1. PRI=10us, AOA=45, PW=200ns, N=18, Inst. BW ≤1GHz, exceeds max N level limit

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.88 | 0.02% (~3MHz) |
| 2 | 15.00 | 0.01% (~1.5MHz) |
| 3 | 14.64 | 0.04% (~6MHz) |
| 4 | 14.12 | 0.03% (~4MHz) |
| 5 | 14.74 | 0.02% (~3MHz) |
| 6 | 14.82 | 0.01% (~1.5MHz) |
| 7 | 14.62 | 0.02% (~3MHz) |
| 8 | 14.66 | 0.01% (~1.5MHz) |
| 9 | 14.68 | 0.03% (~4.5MHz) |
| 10 | 14.10 | 0.02% (~3MHz) |
| 11 | 14.04 | 0.04% (~6MHz) |
| 12 | 14.30 | 0.03% (~4MHz) |
| 13 | 14.20 | 0.01% (~1.5MHz) |
| 14 | 14.78 | 0.02% (~3MHz) |
| 15 | 14.54 | 0.04% (~6MHz) |
| 16 | 14.32 | 0.03% (~4MHz) |
| 17 | 14.76 | 0.02% (~3MHz) |
| 18 | 14.70 | 0.01% (~1.5MHz) |

1. (\*New) PRI=75us, AOA=270, PW=850ns, N=4

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 7.75 | 0.08% (~6MHz) |
| 2 | 7.32 | 0.06% (~4.4MHz) |
| 3 | 7.81 | 0.05% (~4MHz) |
| 4 | 7.12 | 0.10% (~7MHz) |

1. (\*New) PRI=100us, AOA=180, PW=600ns, N=7

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 17.32 | 0.03% (~5.2MHz) |
| 2 | 17.90 | 0.01% (~1.8MHz) |
| 3 | 17.00 | 0.04% (~6.8MHz) |
| 4 | 17.45 | 0.02% (~3.5MHz) |
| 5 | 17.15 | 0.03% (~5.2MHz) |
| 6 | 17.75 | 0.01% (~1.8MHz) |
| 7 | 17.50 | 0.02% (~3.5MHz) |

## Freq Type: Complex

Characterization according to percentage deviation boundary

1. F=4.2GHz, PRI=100us, AOA=45, PW=200ns, ΔF=11% (462 MHz)

To be characterized as **complex** Freq

Characterization according to absolute deviation boundary

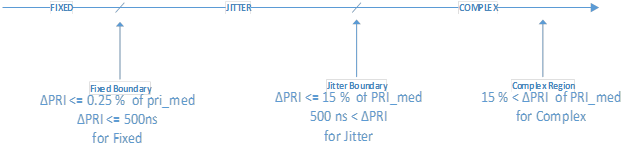
1. F=7.8GHz, PRI=100us, AOA=45, PW=200ns, ΔF=8% (624 MHz)

To be characterized as **complex** Freq

Also cases in the above types which exceed the specified boundaries of known types are also to be classified as complex

# PRI Types

## PRI Types: Fixed and Jitter



Characterization according to percentage deviation boundary

1. F=10GHz, PRI=100us, AOA=45, PW=200ns, ΔPRI= 0.2%(200ns)

To be characterized as **fixed** PRI

1. F=10GHz, PRI=100us, AOA=45, PW=200ns, ΔPRI = 0.3%(300ns)

To be characterized as **jitter** PRI

1. F=10GHz, PRI=20ms, AOA=45, PW=100us, ΔPRI = 0.005%(1us)

To be characterized as **jitter** PRI

Characterization according to absolute deviation boundary

1. F=10GHz, PRI=300us, AOA=45, PW=100us, ΔPRI = 0.2%(600ns)

To be characterized as **jitter** PRI

## PRI Type: Slide

* Currently only saw-tooth has been incorporated. The other types will be incorporated at a later stage.
* A minimum and maximum Step size is applicable
  + Min Step Size: 1us
  + Max Step Size: 50us

1. F=10GHz, AOA=45, PW=200ns, PRI=200us to 300us (positive rate) , Step size = 1us
2. F=10GHz, AOA=45, PW=200ns, PRI = 40us to 1280us (positive rate), Step size = 40us
3. F=10GHz, AOA=45, PW = 200ns, PRI=1800us to 200us (negative rate), Step size = 50us

Cases exceeding the Slide rate limit

1. F=10GHz, AOA=45, PW=200ns, PRI=1800us to 200us (negative rate), Step size = 100us
2. F=10GHz, AOA=45, PW=200ns, PRI=20us to 40us (positive rate), Step size = 500ns

## PRI Type: DWS

* Switching between PRI levels after a particular dwell time
* If the levels present are greater than 32 within the reporting time (which is 200ms), the earliest Level/s will be overwritten by the later ones
* Jitter and Complex conditions apply to each level on its own
* The max deviation for the levels is the same as that of Fixed PRI (0.25% or 500ns)

1. F=10GHz, AOA=45, PW=200ns, N=32

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI | Dwell Time (Pulses) | Dwell Time (us) |
| 1 | 15 | 0.02% (~3ns) | 15 | 225 |
| 2 | 52.5 | 0.01% (~5ns) | 10 | 525 |
| 3 | 85 | 0.03% (~25ns) | 25 | 2125 |
| 4 | 87.5 | 0.20% (~175ns) | 35 | 3062.5 |
| 5 | 50 | 0.04% (~20ns) | 10 | 500 |
| 6 | 27.5 | 0.01% (~3ns) | 30 | 825 |
| 7 | 107.5 | 0.03% (~32ns) | 15 | 1612.5 |
| 8 | 65 | 0.03% (~20ns) | 10 | 650 |
| 9 | 100 | 0.15% (~150ns) | 25 | 2500 |
| 10 | 110 | 0.04% (~44ns) | 35 | 3850 |
| 11 | 95 | 0.01% (~9.5ns) | 10 | 950 |
| 12 | 70 | 0.03% (~21ns) | 30 | 2100 |
| 13 | 90 | 0.04% (~36ns) | 15 | 1350 |
| 14 | 42.5 | 0.01% (~4ns) | 10 | 425 |
| 15 | 10.1 | 0.04% (~4ns) | 25 | 252.5 |
| 16 | 60.3 | 0.01% (~6ns) | 35 | 2110.5 |
| 17 | 105 | 0.02% (~21ns) | 10 | 1050 |
| 18 | 20.1 | 0.03% (~6ns) | 30 | 603 |
| 19 | 17.5 | 0.01% (~2ns) | 15 | 262.5 |
| 20 | 32.5 | 0.03% (~10ns) | 10 | 325 |
| 21 | 30 | 0.20% (~60ns) | 25 | 750 |
| 22 | 55 | 0.04% (~22ns) | 35 | 1925 |
| 23 | 72.5 | 0.15% (~109ns) | 10 | 725 |
| 24 | 82.5 | 0.04% (~33ns) | 30 | 2475 |
| 25 | 62.5 | 0.01% (~6ns) | 15 | 937.5 |
| 26 | 35 | 0.05% (~17.5ns) | 10 | 350 |
| 27 | 47.5 | 0.03% (~14ns) | 25 | 1187.5 |
| 28 | 45 | 0.20% (~90ns) | 35 | 1575 |
| 29 | 75 | 0.04% (~30ns) | 10 | 750 |
| 30 | 37.5 | 0.06% (~22.5ns) | 30 | 1125 |
| 31 | 67.5 | 0.02% (~13.5ns) | 25 | 1687.5 |
| 32 | 40 | 0.04% (~16ns) | 35 | 1400 |

1. F=10GHz, AOA=45, PW=200ns, N=35

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI | Dwell Time (Pulses) | Dwell Time (us) |
| 1 | 15 | 0.02% (~3ns) | 15 | 225 |
| 2 | 52.5 | 0.01% (~5ns) | 10 | 525 |
| 3 | 85 | 0.03% (~25ns) | 25 | 2125 |
| 4 | 87.5 | 0.20% (~175ns) | 35 | 3062.5 |
| 5 | 50 | 0.04% (~20ns) | 10 | 500 |
| 6 | 27.5 | 0.01% (~3ns) | 30 | 825 |
| 7 | 107.5 | 0.03% (~32ns) | 15 | 1612.5 |
| 8 | 65 | 0.03% (~20ns) | 10 | 650 |
| 9 | 100 | 0.15% (~150ns) | 25 | 2500 |
| 10 | 110 | 0.04% (~44ns) | 35 | 3850 |
| 11 | 95 | 0.01% (~9.5ns) | 10 | 950 |
| 12 | 70 | 0.03% (~21ns) | 30 | 2100 |
| 13 | 90 | 0.04% (~36ns) | 15 | 1350 |
| 14 | 42.5 | 0.01% (~4ns) | 10 | 425 |
| 15 | 10.1 | 0.04% (~4ns) | 25 | 252.5 |
| 16 | 60.3 | 0.01% (~6ns) | 35 | 2110.5 |
| 17 | 105 | 0.02% (~21ns) | 10 | 1050 |
| 18 | 20.1 | 0.03% (~6ns) | 30 | 603 |
| 19 | 17.5 | 0.01% (~2ns) | 15 | 262.5 |
| 20 | 32.5 | 0.03% (~10ns) | 10 | 325 |
| 21 | 30 | 0.20% (~60ns) | 25 | 750 |
| 22 | 55 | 0.04% (~22ns) | 35 | 1925 |
| 23 | 72.5 | 0.15% (~109ns) | 10 | 725 |
| 24 | 82.5 | 0.04% (~33ns) | 30 | 2475 |
| 25 | 62.5 | 0.01% (~6ns) | 15 | 937.5 |
| 26 | 35 | 0.05% (~17.5ns) | 10 | 350 |
| 27 | 47.5 | 0.03% (~14ns) | 25 | 1187.5 |
| 28 | 45 | 0.20% (~90ns) | 35 | 1575 |
| 29 | 75 | 0.04% (~30ns) | 10 | 750 |
| 30 | 37.5 | 0.06% (~22.5ns) | 30 | 1125 |
| 31 | 67.5 | 0.02% (~13.5ns) | 25 | 1687.5 |
| 32 | 40 | 0.04% (~16ns) | 35 | 1400 |
| 33 | 121.5 | 0.04% (~50ns) | 10 | 1215 |
| 34 | 8.5 | 0.20% (~20ns) | 30 | 255 |
| 35 | 115.5 | 0.05% (~58ns) | 15 | 1732.5 |

1. F=10GHz, AOA=45, PW=200ns, N=5, deviations exceed limits in some levels

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI | Dwell Time (us) |
| 1 | 121.5 | 0.45% (~550ns) | 1215us (10 pulses) |
| 2 | 60 | 0.01% (~6ns) | 600us (10 pulses) |
| 3 | 82 | 0.03% (~2.5ns) | 1804us (22 pulses) |
| 4 | 102.5 | 0.30% (~307ns) | 2562.5us (25 pulses) |
| 5 | 92.5 | 0.04% (~40ns) | 3237.5 (35 pulses) |

1. F=10GHz, AOA=45, PW=200ns, N=5, insufficient pulses in some levels

|  |  |  |  |
| --- | --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI | Dwell Time (us) |
| 1 | 73 | 0.02% (~15ns) | 1095us (15 pulses) |
| 2 | 60 | 0.01% (~6ns) | 600us (10 pulses) |
| 3 | 82 | 0.03% (~2.5ns) | 328us (4 pulses) |
| 4 | 102.5 | 0.20% (~205ns) | 2562.5us (25 pulses) |
| 5 | 92.5 | 0.04% (~40ns) | 277.5us (3 pulses) |

## PRI Type: Stagger

* levels 2 ≤N ≤32
* Minimum pulse group repetition intervals (PGRI) ≥ 3

1. F=10GHz, AOA=45, PW=200ns, N=32, no deviations

|  |  |
| --- | --- |
| S.No | PRI Spots (us) |
| 1 | 15 |
| 2 | 52.5 |
| 3 | 85 |
| 4 | 87.5 |
| 5 | 50 |
| 6 | 27.5 |
| 7 | 107.5 |
| 8 | 65 |
| 9 | 100 |
| 10 | 110 |
| 11 | 95 |
| 12 | 70 |
| 13 | 90 |
| 14 | 42.5 |
| 15 | 10.1 |
| 16 | 60.3 |
| 17 | 105 |
| 18 | 20.1 |
| 19 | 17.5 |
| 20 | 32.5 |
| 21 | 30 |
| 22 | 55 |
| 23 | 72.5 |
| 24 | 82.5 |
| 25 | 62.5 |
| 26 | 35 |
| 27 | 47.5 |
| 28 | 45 |
| 29 | 75 |
| 30 | 37.5 |
| 31 | 67.5 |
| 32 | 40 |

1. F=10GHz, AOA=45, PW=200ns, N=5, with deviations

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 110 | 0.04% (~44ns) |
| 2 | 55 | 0.04% (~22ns) |
| 3 | 47.5 | 0.03% (~14ns) |
| 4 | 30 | 0.20% (~60ns) |
| 5 | 32.5 | 0.03% (~10ns) |

1. F=10GHz, AOA=45, PW=200ns, N=5, with larger deviations

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 110 | 0.2 (~220 ns) |
| 2 | 55 | 0.15 (~82.5 ns) |
| 3 | 47.5 | 0.3 (~142.5 ns) |
| 4 | 30 | 0.25 (~75 ns) |
| 5 | 32.5 | 0.1 (~32.5 ns) |

1. F=10GHz, AOA=45, PW=200ns, N=16, with deviations greater than 150ns within total frame

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 110 | 0.04% (~44ns) |
| 2 | 95 | 0.01% (~9.5ns) |
| 3 | 70 | 0.03% (~21ns) |
| 4 | 90 | 0.04% (~36ns) |
| 5 | 42.5 | 0.01% (~4ns) |
| 6 | 10.1 | 0.04% (~4ns) |
| 7 | 60.3 | 0.01% (~6ns) |
| 8 | 45 | 0.20% (~90ns) |
| 9 | 75 | 0.04% (~30ns) |
| 10 | 37.5 | 0.06% (~22.5ns) |
| 11 | 67.5 | 0.02% (~13.5ns) |
| 12 | 40 | 0.04% (~16ns) |
| 13 | 50 | 0.04% (~20ns) |
| 14 | 27.5 | 0.01% (~3ns) |
| 15 | 107.5 | 0.03% (~32ns) |
| 16 | 65 | 0.03% (~20ns) |

1. F=10GHz, AOA=45, PW=200ns, N=32, with deviations greater than 150ns within total frame

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 15 | 0.02% (~3ns) |
| 2 | 52.5 | 0.01% (~5ns) |
| 3 | 85 | 0.03% (~25ns) |
| 4 | 87.5 | 0.20% (~175ns) |
| 5 | 50 | 0.04% (~20ns) |
| 6 | 27.5 | 0.01% (~3ns) |
| 7 | 107.5 | 0.03% (~32ns) |
| 8 | 65 | 0.03% (~20ns) |
| 9 | 100 | 0.15% (~150ns) |
| 10 | 110 | 0.04% (~44ns) |
| 11 | 95 | 0.01% (~9.5ns) |
| 12 | 70 | 0.03% (~21ns) |
| 13 | 90 | 0.04% (~36ns) |
| 14 | 42.5 | 0.01% (~4ns) |
| 15 | 10.1 | 0.04% (~4ns) |
| 16 | 60.3 | 0.01% (~6ns) |
| 17 | 105 | 0.02% (~21ns) |
| 18 | 20.1 | 0.03% (~6ns) |
| 19 | 17.5 | 0.01% (~2ns) |
| 20 | 32.5 | 0.03% (~10ns) |
| 21 | 30 | 0.20% (~60ns) |
| 22 | 55 | 0.04% (~22ns) |
| 23 | 72.5 | 0.15% (~109ns) |
| 24 | 82.5 | 0.04% (~33ns) |
| 25 | 62.5 | 0.01% (~6ns) |
| 26 | 35 | 0.05% (~17.5ns) |
| 27 | 47.5 | 0.03% (~14ns) |
| 28 | 45 | 0.20% (~90ns) |
| 29 | 75 | 0.04% (~30ns) |
| 30 | 37.5 | 0.06% (~22.5ns) |
| 31 | 67.5 | 0.02% (~13.5ns) |
| 32 | 40 | 0.04% (~16ns) |

1. F=10GHz, AOA=45, PW=200ns, N=35, exceeds max N level limits, with deviations

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 15 | 0.02% (~3ns) |
| 2 | 52.5 | 0.01% (~5ns) |
| 3 | 85 | 0.03% (~25ns) |
| 4 | 87.5 | 0.20% (~175ns) |
| 5 | 50 | 0.04% (~20ns) |
| 6 | 27.5 | 0.01% (~3ns) |
| 7 | 107.5 | 0.03% (~32ns) |
| 8 | 65 | 0.03% (~20ns) |
| 9 | 100 | 0.15% (~150ns) |
| 10 | 110 | 0.04% (~44ns) |
| 11 | 95 | 0.01% (~9.5ns) |
| 12 | 70 | 0.03% (~21ns) |
| 13 | 90 | 0.04% (~36ns) |
| 14 | 42.5 | 0.01% (~4ns) |
| 15 | 10.1 | 0.04% (~4ns) |
| 16 | 60.3 | 0.01% (~6ns) |
| 17 | 105 | 0.02% (~21ns) |
| 18 | 20.1 | 0.03% (~6ns) |
| 19 | 17.5 | 0.01% (~2ns) |
| 20 | 32.5 | 0.03% (~10ns) |
| 21 | 30 | 0.20% (~60ns) |
| 22 | 55 | 0.04% (~22ns) |
| 23 | 72.5 | 0.15% (~109ns) |
| 24 | 82.5 | 0.04% (~33ns) |
| 25 | 62.5 | 0.01% (~6ns) |
| 26 | 35 | 0.05% (~17.5ns) |
| 27 | 47.5 | 0.03% (~14ns) |
| 28 | 45 | 0.20% (~90ns) |
| 29 | 75 | 0.04% (~30ns) |
| 30 | 37.5 | 0.06% (~22.5ns) |
| 31 | 67.5 | 0.02% (~13.5ns) |
| 32 | 40 | 0.04% (~16ns) |
| 33 | 121.5 | 0.04% (~50ns) |
| 34 | 8.5 | 0.20% (~20ns) |
| 35 | 115.5 | 0.05% (~58ns) |

1. (\*New) F=10GHz, AOA=45, PW=200ns, N=32, deviations within 150ns in total frame

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 15 |  |
| 2 | 52.5 |  |
| 3 | 85 |  |
| 4 | 87.5 |  |
| 5 | 50 | 0.04% (~20ns) |
| 6 | 27.5 |  |
| 7 | 107.5 |  |
| 8 | 65 | 0.03% (~20ns) |
| 9 | 100 |  |
| 10 | 110 |  |
| 11 | 95 |  |
| 12 | 70 |  |
| 13 | 90 |  |
| 14 | 42.5 |  |
| 15 | 10.1 |  |
| 16 | 60.3 |  |
| 17 | 105 |  |
| 18 | 20.1 |  |
| 19 | 17.5 |  |
| 20 | 32.5 | 0.03% (~10ns) |
| 21 | 30 |  |
| 22 | 55 |  |
| 23 | 72.5 |  |
| 24 | 82.5 |  |
| 25 | 62.5 |  |
| 26 | 35 |  |
| 27 | 47.5 |  |
| 28 | 45 |  |
| 29 | 75 | 0.04% (~30ns) |
| 30 | 37.5 |  |
| 31 | 67.5 |  |
| 32 | 40 |  |

1. (\*New) F=10GHz, AOA=45, PW=200ns, N=16, with deviations within 150ns of total frame

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 110 |  |
| 2 | 95 |  |
| 3 | 70 | 0.03% (~21ns) |
| 4 | 90 |  |
| 5 | 42.5 |  |
| 6 | 10.1 |  |
| 7 | 60.3 |  |
| 8 | 45 |  |
| 9 | 75 | 0.04% (~30ns) |
| 10 | 37.5 |  |
| 11 | 67.5 |  |
| 12 | 40 |  |
| 13 | 50 | 0.04% (~20ns) |
| 14 | 27.5 |  |
| 15 | 107.5 |  |
| 16 | 65 | 0.03% (~20ns) |

1. (\*New) F=10GHz, AOA=45, PW=200ns, N=35, exceeds max N level limits, no deviations

|  |  |
| --- | --- |
| S.No | PRI Spots (us) |
| 1 | 15 |
| 2 | 52.5 |
| 3 | 85 |
| 4 | 87.5 |
| 5 | 50 |
| 6 | 27.5 |
| 7 | 107.5 |
| 8 | 65 |
| 9 | 100 |
| 10 | 110 |
| 11 | 95 |
| 12 | 70 |
| 13 | 90 |
| 14 | 42.5 |
| 15 | 10.1 |
| 16 | 60.3 |
| 17 | 105 |
| 18 | 20.1 |
| 19 | 17.5 |
| 20 | 32.5 |
| 21 | 30 |
| 22 | 55 |
| 23 | 72.5 |
| 24 | 82.5 |
| 25 | 62.5 |
| 26 | 35 |
| 27 | 47.5 |
| 28 | 45 |
| 29 | 75 |
| 30 | 37.5 |
| 31 | 67.5 |
| 32 | 40 |
| 33 | 121.5 |
| 34 | 8.5 |
| 35 | 115.5 |

## PRI Type: Complex

Characterization according to percentage deviation boundary

1. F=10GHz, PRI=5us, AOA=45, PW=200ns, ΔPRI=18% (900ns)

To be characterized as **complex** PRI

Characterization according to absolute deviation boundary

1. F=10GHz, PRI=100us, AOA=45, PW=200ns, ΔPRI=8% (8000ns)

To be characterized as **complex** PRI

Also cases in the above types which exceed the specified boundaries of known types are also to be classified as complex

# Multiple Emitters and Tracking Scenarios

The scenarios described below aim to demonstrate the de-interleaving and tracking capabilities of the TP algorithm.

1. Four simultaneous threats appearing at same time

Emitter 1: F=14.2GHz, PRI=500us, AOA=15, PW=200ns, ΔPRI= 0.3% (Jitter PRI)

Emitter 2: F=14.6GHz, PRI=105us, AOA=45, PW=480ns, ΔPW = 14% (Agile PW)

Emitter 3: F=3.4GHz, PRI=25.5us, AOA=120, PW=120ns, ΔF= 0.1% (Fixed Freq)

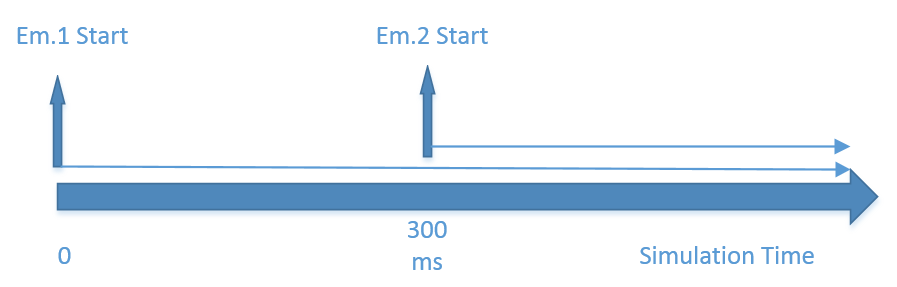
Emitter 4: F=17.8GHz, PRI=321.5us, AOA=225, PW=100us, ΔPRI = 0.15% (Fixed PRI)

1. One Emitter being tracked and second appearing after some delay

Emitter 1: F=3.4GHz, PRI=25.5us, AOA=120, PW=120ns, ΔF= 0.1% (Fixed Freq)

Emitter 2: F=14.2GHz, PRI=500us, AOA=15, PW=200ns, ΔPRI= 0.3% (Jitter PRI)

Emitter 2 will appear after a delay of 300ms



1. Multiple emitters, one emitter intermittent
   * 1. Case 1

Emitter 1: F=14.6GHz, PRI=105us, AOA=45, PW=480ns, ΔPW = 14% (Agile PW)

Emitter 2: F=3.4GHz, PRI=25.5us, AOA=120, PW=120ns, ΔF= 0.1% (Fixed Freq)

Emitter 2 silent after a period of 600ms and for duration of 300ms, around 11765 pulses for Emitter 2 will be missed.



* + 1. Case 2

Emitter 1: F=14.6GHz, PRI=105us, AOA=45, PW=480ns, ΔPW = 14% (Agile PW)

Emitter 2: F=3.4GHz, PRI=25.5us, AOA=120, PW=120ns, ΔF= 0.1% (Fixed Freq)

Emitter 2 silent after a period of 500us and for duration of 400us, around 16 pulses will be missed after about every 4 pulses



1. Multiple emitters complete periodic blanking of environment

Emitter 1: F=3.4GHz, PRI=25us, AOA=120, PW=120ns, ΔF= 0.1% (Fixed Freq)

Emitter 2: F=17.8GHz, PRI=100us, AOA=225, PW=100us, ΔPRI = 0.15% (Fixed PRI)

Complete blanking period 100ms and duration 10ms



1. Tracking of single emitter with changing angle of arrival

Emitter 1: F=3.4GHz, PRI=200us, AOA=45, PW=120ns, ΔF= 0.1% (Fixed Freq)

AOA will increment by 1 degree after every 10ms

1. Single emitter with random frequency hopping and PRI jitter (Special Case)

Emitter 1 PRI=100us, AOA=45, PW=200ns, ΔPRI = 0.3%(300ns)

Freq Jump:

|  |  |  |
| --- | --- | --- |
| S.No | F Spots | ΔF |
| 1 | 14.62 | 0.02% (~3MHz) |
| 2 | 14.66 | 0.01% (~1.5MHz) |
| 3 | 14.68 | 0.03% (~4.5MHz) |
| 4 | 14.10 | 0.02% (~3MHz) |
| 5 | 14.04 | 0.04% (~6MHz) |
| 6 | 14.30 | 0.03% (~4MHz) |
| 7 | 14.20 | 0.01% (~1.5MHz) |
| 8 | 14.58 | 0.02% (~3MHz) |

1. Single emitter with injection of spurious pulses

Emitter 1: F=3.4GHz, PRI=25.5us, AOA=120, PW=120ns, ΔPRI= 0.10% (Fixed PRI)

The emitter will be injected with 10 spurious pulses. Injection will be done by introducing a second emitter with the same parameters as of Emitter 1 after some delay which corresponds to the time where injection occurs.

1. Emitters with missing pulses effect

Both cases described below will be tested with random missing pulses at rates of: 10, 20, 40, 60 and 80% missing pulses in order to determine the percentage after which missing pulses affect the TP response.

* + 1. Case 1

Emitter 1: F=3.4GHz, PRI=25.5us, AOA=120, PW=120ns, ΔPRI= 0.10% (Fixed PRI)

* + 1. Case 2

Emitter 1: F=14.6GHz, PRI=105us, AOA=45, PW=480ns, ΔPW = 14% (Agile PW)

Emitter 2: F=10GHz, AOA=120, PW=200ns, N=5

|  |  |  |
| --- | --- | --- |
| S.No | PRI Spots (us) | ΔPRI |
| 1 | 20.1 | 0.02% (~4ns) |
| 2 | 17.5 | 0.01% (~2ns) |
| 3 | 32.5 | 0.03% (~10ns) |
| 4 | 30 | 0.20% (~60ns) |
| 5 | 55 | 0.04% (~22ns) |

1. Maximum Pulse density test of 2 Million PDWs per second

Emitter 1: F=10GHz, PRI=500ns, AOA=45, PW=100ns

**Note:** All test cases for emitter type identification and tracking capabilities will have the effect of antenna/band switching, realistic pulse shaping and noise in video and carrier signals.

**.**