**3GPP TSG-WG4 Meeting #99-e *R4-21xxxxx***

**Electronic Meeting, May. 19-27, 2021**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
|  |
|  | **38.101-1** | **CR** | **0865** | **rev** | **1** | **Current version:** | **16.7.0** |  |
|  |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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|  |
| ***Title:***  | CR for TS 38.101-1 Tx diversity requirements |
|  |  |
| ***Source to WG:*** | Huawei, HiSilicon, vivo, OPPO |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | TEI16 |  | ***Date:*** | 2021-03-30 |
|  |  |  |  |  |
| ***Category:*** | **B** |  | ***Release:*** | Rel-16 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)Rel-12 (Release 12)**Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
|  |  |
| ***Reason for change:*** | Introdue transparent Tx diversity requirements in TS 38.101-1.  |
|  |  |
| ***Summary of change:*** | The following requirements of TxD with new sub-clauses are introduced.* UE maximum output power
* MPR
* Configured transmitted power
* Minimum output power
* Transmit OFF power
* Transmit ON/OFF time mask
* Power Control
* Transmit signal quality
* Out of band emission
* ACLR
* Annex: EVM measurement for dual Tx
1. The TxD requirements for Rel-16 are based on new UE capability according to agreement in GTW meeting in RAN4#98e.
2. Based on the WF in R4-2011768, for power and emissions, the requirements are defined as the sum of powers from both connectors.
3. Add new PC2 requirement for UE supporting dual Tx according to the revised unwanted emissions specified per UE rather than per antenna connector
4. The ACLR requirement based on WF in R4-2008465
5. EVM requirement in current version is based on WF in R4-2105330.
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| ***Consequences if not approved:*** | Requirements are ambiguous in the specification. Transparent Tx diversity cannot be well supported in the specification.  |
|  |  |
| ***Clauses affected:*** | 3.3, 4.2, 6.2G, 6.3G, 6.4G, 6.5G, F.8 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **X** |  |  Test specifications | TS 38.521-1  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** | 1. Change “measured” to “defined” in 6.2G.2 and 6.2G.3.2. remove MPR table for PC2 with 2Tx, which will be further determined in next meeting according to GTW WF. |

## **<Start of Change>**

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1].

ACLR Adjacent Channel Leakage Ratio

ACS Adjacent Channel Selectivity

A-MPR Additional Maximum Power Reduction

BS Base Station

BW Bandwidth

BWP Bandwidth Part

CA Carrier Aggregation

CA\_nX-nY Inter-band CA of component carrier(s) in one sub-block within Band X and component carrier(s) in one sub-block within Band Y where X and Y are the applicable NR *operating band*

CC Component Carriers

CG Carrier Group

CP-OFDM Cyclic Prefix-OFDM

CW Continuous Wave

DC Dual Connectivity

DFT-s-OFDM Discrete Fourier Transform-spread-OFDM

DM-RS Demodulation Reference Signal

DTX Discontinuous Transmission

E-UTRA Evolved UTRA

EIRP Equivalent Isotropically Radiated Power

EVM Error Vector Magnitude

FR Frequency Range

FRC Fixed Reference Channel

FWA Fixed Wireless Access

GSCN Global Synchronization Channel Number

IBB In-band Blocking

IDFT Inverse Discrete Fourier Transformation

ITS Intelligent Transportation System

ITU‑R Radiocommunication Sector of the International Telecommunication Union

MBW Measurement bandwidth defined for the protected band

MCG Master Cell Group

MOP Maximum Output Power

MPR Allowed maximum power reduction

MSD Maximum Sensitivity Degradation

NR New Radio

NR-ARFCN NR Absolute Radio Frequency Channel Number

NS Network Signalling

OCNG OFDMA Channel Noise Generator

OOB Out-of-band

P-MPR Power Management Maximum Power Reduction

PRB Physical Resource Block

PSCCH Physical Sidelink Control CHannel

PSSCH Physical Sidelink Shared CHannel

QAM Quadrature Amplitude Modulation

RE Resource Element

REFSENS Reference Sensitivity

RF Radio Frequency

RMS Root Mean Square (value)

RSRP Reference Signal Receiving PowerRx Receiver

SC Single Carrier

SCG Secondary Cell Group

SCS Subcarrier spacing

SDL Supplementary Downlink

SEM Spectrum Emission Mask

SL Sidelink

SL-MIMO Sidelink-Multiple Antenna transmission

SNR Signal-to-Noise Ratio

SRS Sounding Reference Symbol

SUL Supplementary uplink

SS Synchronization Symbol

TAE Time Alignment Error

TAG Timing Advance Group

Tx Transmitter

TxD Tx Diversity

UL MIMO Uplink Multiple Antenna transmission

ULFPTx Uplink Full Power Transmission

V2X Vehicle to Everything

### **<Next Change>**

## 4.2 Applicability of minimum requirements

a) In this specification the Minimum Requirements are specified as general requirements and additional requirements. Where the Requirement is specified as a general requirement, the requirement is mandated to be met in all scenarios

b) For specific scenarios for which an additional requirement is specified, in addition to meeting the general requirement, the UE is mandated to meet the additional requirements.

c) The spurious emissions power requirements are for the long-term average of the power. For the purpose of reducing measurement uncertainty it is acceptable to average the measured power over a period of time sufficient to reduce the uncertainty due to the statistical nature of the signal

d) All the requirements for intra-band contiguous and non-contiguous CA apply under the assumption of the same slot format indicated by UL-DL-configuration-common in the PCell and SCells for NR SA.

e) The requirements for Tx diversity in this release are applied for UE which indicates IE [*txDiversity-r16*].

## 4.3 Specification suffix information

Unless stated otherwise the following suffixes are used for indicating at 2nd level clause, shown in Table 4.3-1.

Table 4.3-1: Definition of suffixes

|  |  |
| --- | --- |
| Clause suffix | Variant |
| None | Single Carrier |
| A | Carrier Aggregation (CA) |
| B | Dual-Connectivity (DC) |
| C | Supplement Uplink (SUL) |
| D | UL MIMO |
| E | V2X |
| F | Shared spectrum channel access |
| G | Tx Diversity (TxD) |

A terminal which supports the above features needs to meet both the general requirements and the additional requirement applicable to the additional clause (suffixes A to F) in clauses 5, 6 and 7. Where there is a difference in requirement between the general requirements and the additional clause requirements (suffixes A to F) in clauses 5, 6 and 7, the tighter requirements are applicable unless stated otherwise in the additional clause.

A terminal which supports more than one feature in clauses 5, 6 and 7 shall meet all of the separate corresponding requirements.

For a terminal that supports SUL for the band combination specified in Table 5.2C-1, the current version of the specification assumes the terminal is configured with active transmission either on UL carrier or SUL carrier at any time in one serving cell and the UE requirements for single carrier shall apply for the active UL or SUL carrier accordingly. For a terminal that supports SUL, the current version of the specification assumes the terminal is not configured with UL MIMO on SUL carrier.

For a terminal that supports operation in shared spectrum, the current version of this specification assumes in the uplink sub-bands within a wideband channel shall be contiguously allocated to the UE. The uplink requirements for one or more non-transmitted sub-bands between two transmitted sub-bands does not form a part of the current version of this specification.

### **<Next Change>**

### 6.2.2 UE maximum output power reduction

UE is allowed to reduce the maximum output power due to higher order modulations and transmit bandwidth configurations. For UE power class 1.5, 2 and 3, the allowed maximum power reduction (MPR) is defined in Table 6.2.2-4, Table 6.2.2-2, Table 6.2.2-2a and Table 6.2.2-1, respectively for channel bandwidths that meets both following criteria:

Channel bandwidth ≤ 100 MHz.

Relative channel bandwidth ≤ 4 % for TDD bands and ≤ 3 % for FDD bands. Unless otherwise stated, the ∆MPR is set to zero.

If the relative channel bandwidth is larger than 4% for TDD bands or 3% for FDD bands, the ∆MPR is defined in Table 6.2.2-3.

Where relative channel bandwith = 2\*BWChannel / (FUL\_low + FUL\_high)

The allowed MPR for SRS, PUCCH formats 0, 1, 3 and 4, and PRACH shall be as specified for QPSK modulated DFT-s-OFDM of equivalent RB allocation. The allowed MPR for PUCCH format 2 shall be as specified for QPSK modulated CP-OFDM of equivalent RB allocation.

Table 6.2.2-1 Maximum power reduction (MPR) for power class 3

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM  | Pi/2 BPSK | ≤ 3.51 | ≤ 1.21 | ≤ 0.21 |
| ≤ 0.52 | ≤ 0.52 | 02 |
| Pi/2 BPSK w Pi/2 BPSK DMRS | ≤ 0.52 | ≤ 02 | 02 |
| QPSK | ≤ 1 | 0 |
| 16 QAM | ≤ 2 | ≤ 1 |
| 64 QAM | ≤ 2.5 |
| 256 QAM | ≤ 4.5 |
| CP-OFDM  | QPSK | ≤ 3 | ≤ 1.5 |
| 16 QAM | ≤ 3 | ≤ 2 |
| 64 QAM | ≤ 3.5 |
| 256 QAM | ≤ 6.5 |
| NOTE 1: Applicable for UE operating in TDD mode with Pi/2 BPSK modulation and UE indicates support for UE capability *powerBoosting-pi2BPSK* and if the IE *powerBoostPi2BPSK* is set to 1 and 40 % or less slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79. The reference power of 0 dB MPR is 26 dBm.NOTE 2: Applicable for UE operating in FDD mode, or in TDD mode in bands other than n40, n41, n77, n78 and n79 with Pi/2 BPSK modulation and if the IE *powerBoostPi2BPSK* is set to 0 and if more than 40 % of slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79. NOTE 3: The MPR is applied to the sum of the output power at each transmit antenna connector for UL MIMO or TxD. |

Table 6.2.2-2 Maximum power reduction (MPR) for power class 2 with one Tx

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM  | Pi/2 BPSK | ≤ 3.5 | ≤ 0.5 | 0 |
| QPSK | ≤ 3.5 | ≤ 1 | 0 |
| 16 QAM | ≤ 3.5 | ≤ 2 | ≤ 1 |
| 64 QAM | ≤ 3.5 | ≤ 2.5 |
| 256 QAM | ≤ 4.5 |
| CP-OFDM  | QPSK | ≤ 3.5 | ≤ 3 | ≤ 1.5 |
| 16 QAM | ≤ 3.5 | ≤ 3 | ≤ 2 |
| 64 QAM | ≤ 3.5 |
| 256 QAM | ≤ 6.5 |

Table 6.2.2-3: ∆MPR

|  |  |  |  |
| --- | --- | --- | --- |
| NR Band | Power class | Channel bandwidth | ∆MPR (dB) |
| n28 | Power class 3 | 30 MHz | 0.5 |

Table 6.2.2-4 Maximum power reduction (MPR) for power class 1.5 with dual Tx

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
| Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM  | Pi/2 BPSK | ≤ 6.5 | ≤ 3.5 | ≤ 1.5 |
| QPSK | ≤ 6.5 | ≤ 4 | ≤ 1.5 |
| 16 QAM | ≤ 6.5 | ≤ 5 | ≤ 2.5 |
| 64 QAM | ≤ 6.5 | ≤ 5.5 | ≤ 4 |
| 256 QAM | ≤ 7.5 | ≤ 7.5 | ≤ 7.5 |
| CP-OFDM  | QPSK | ≤ 6.5 | ≤ 6 | ≤ 3 |
| 16 QAM | ≤ 6.5 | ≤ 6 | ≤ 3.5 |
| 64 QAM | ≤ 6.5 | ≤ 6.5 | ≤ 5 |
| 256 QAM | ≤ 9.5 | ≤ 9.5 | ≤ 9.5 |
| NOTE 1: The MPR is applied to the sum of the output power at each transmit antenna connector. |

Where the following parameters are defined to specify valid RB allocation ranges for Outer and Inner RB allocations:

NRB is the maximum number of RBs for a given Channel bandwidth and sub-carrier spacing defined in Table 5.3.2-1. RBStart,Low = max(1, floor(LCRB/2))

where max() indicates the largest value of all arguments and floor(x) is the greatest integer less than or equal to x.

RBStart,High = NRB – RBStart,Low – LCRB

The RB allocation is an Inner RB allocation if the following conditions are met

RBStart,Low ≤ RBStart ≤ RBStart,High,and

LCRB ≤ ceil(NRB/2)

where ceil(x) is the smallest integer greater than or equal to x.

An Edge RB allocation is the one for which the RB(s) is (are) allocated at the lowermost or uppermost edge of the channel with LCRB ≤ 2 RBs.

The RB allocation is an Outer RB allocation for all other allocations which are not an Inner RB allocation or Edge RB allocation.

If CP-OFDM allocation satisfies following conditions, it is considered as almost contiguous allocation

NRB\_gap / (NRB\_alloc + NRB\_gap ) ≤ 0.25

and NRB\_alloc + NRB\_gap is larger than 106, 51 or 24 RBs for 15 kHz, 30 kHz or 60 kHz respectively where NRB\_gap is the total number of unallocated RBs between allocated RBs and NRB\_alloc is the total number of allocated RBs. The size and location of allocated and unallocated RBs are restricted by RBG parameters specified in clause 6.1.2.2 of TS 38.214 [10]. For these almost contiguous signals in power class 2 and 3, the allowed maximum power reduction defined in Table 6.2.2-1 is increased by

CEIL{ 10 log10(1 + NRB\_gap / NRB\_alloc), 0.5 } dB,

where CEIL{x,0.5} means x rounding upwards to closest 0.5dB. The parameters of RBStart,Low and RBStart,High to specify valid RB allocation ranges for Outer and Inner RB allocations are defined as following:

RBStart,Low = max(1, floor((NRB\_alloc + NRB\_gap)/2))

RBStart,High = NRB – RBStart,Low – NRB\_alloc –NRB\_gap

For the UE maximum output power modified by MPR, the power limits specified in clause 6.2.4 apply.

### **<Next Change>**

## 6.2G Transmitter power for Tx Diversity

### 6.2G.1 UE maximum output power for Tx Diversity

For UE supporting Tx Diversity, the maximum output power as indicated by UE power class in Table 6.2.1-1is defined as the sum of the maximum output power from both UE antenna connectors. The period of measurement shall be at least one sub frame (1 ms).

### 6.2G.2 UE maximum output power reduction for Tx Diversity

For UE supporting Tx diversity, the allowed MPR for the maximum output power in Table 6.2.1-1 is specified in [Table 6.2.2-1 and Table 6.2.2-4] for UE power class 3 and 1.5 respectively. The maximum output power is defined as the sum of the maximum output power at each UE antenna connector.

### 6.2G.3 UE additional maximum output power reduction for Tx Diversity

For UE supporting Tx diversity, the A-MPR values specified in clause 6.2.3 shall apply to the maximum output power specified in Table 6.2.1-1, and the maximum output power is definedas the sum of the maximum output power at each UE antenna connector. Unless stated otherwise, an A-MPR of 0 dB shall be used.

### 6.2G.4 Configured transmitted power for Tx Diversity

For UE supporting Tx diversity, the transmitted power is configured per each UE.

The definitions of configured maximum output power PCMAX,*c*, the lower bound PCMAX\_L,*c*, and the higher bound PCMAX\_H,*c* specified in clause 6.2.4 shall apply to UE supporting Tx diverstidy, where

- PPowerClass, ΔPPowerClass and ∆TC,c are specified in clause 6.2.4 unless otherwise stated;

- MPRc is specified in clause 6.2G.2;

The measured configured maximum output power PUMAX,*c* for serving cell *c* shall be within the following bounds:

PCMAX\_L,*c*– MAX{TL, T LOW(PCMAX\_L,*c*)} ≤ PUMAX,*c* ≤ PCMAX\_H,*c*+ T HIGH(PCMAX\_H,*c*)

where TLOW(PCMAX\_L,*c*) and THIGH(PCMAX\_H,*c*) are defined as the tolerance and applies to PCMAX\_L,*c* and PCMAX\_H,*c* separately, while TL is the absolute value of the lower tolerance in Table 6.2.1-1 for the applicable operating band.

For UE supporting Tx diversity, the tolerance is specified in Table 6.2G.4-1.

Table 6.2G.4-1: PCMAX,*c* tolerance for Tx Diverstiy

|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | ToleranceTLOW(PCMAX\_L,*c*) (dB) | ToleranceTHIGH(PCMAX\_H,*c*) (dB) |
| PCMAX,*c* = 26 | 3.0 | 2.0 |
| 23 ≤ PCMAX,*c* < 26 | 3.0 | 2.0 |
| 22 ≤ PCMAX,*c* < 23 | 5.0 | 2.0 |
| 21 ≤ PCMAX,*c* < 22 | 5.0 | 3.0 |
| 20 ≤ PCMAX,*c* < 21 | 6.0 | 4.0 |
| 16 ≤ PCMAX,*c* < 20 | 5.0 |
| 11 ≤ PCMAX,*c* < 16 | 6.0 |
| -40 ≤ PCMAX,*c* < 11 | 7.0 |

### **<Next Change>**

## 6.3G Output power dynamics for Tx Diversity

### 6.3G.1 Minimum output power for Tx Diversity

For UE supporting Tx diversity, the minimum output power is defined as the sum of the mean power at each transmit connector in one sub-frame (1 ms). The minimum output power shall not exceed the values specified in Table 6.3.1-1.

### 6.3G.2 Transmit OFF power for Tx Diversity

For UE supporting Tx diverstidy, the transmit OFF power is defined as the mean power at each transmit antenna connector in a duration of at least one sub-frame (1 ms) excluding any transient periods.

The transmit OFF power at each transmit antenna connector shall not exceed the values specified in Table 6.3.2-1.

### 6.3G.3 Transmit ON/OFF time mask for Tx Diversity

For UE supporting Tx diversity, the ON/OFF time mask requirements in clause 6.3.3 apply at each transmit antenna connector.

### 6.3G.4 Power control for Tx Diversity

For UE supporting Tx diversity, the power control tolerance applies to the sum of output power at each transmit antenna connector.

### **<Next Change>**

## 6.4G Transmit signal quality for Tx Diversity

### 6.4G.1 Frequency error for Tx Diversity

For UE(s) supporting Tx diversity, the basic measurement interval of modulated carrier frequency is 1 UL slot. The mean value of basic measurements of UE modulated carrier frequency at each transmit antenna connector shall be accurate to within ± 0.1 PPM observed over a period of 1 ms of cumulated measurement intervals compared to the carrier frequency received from the NR Node B.

### 6.4G.2 Transmit modulation quality for Tx Diversity

For UE supporting Tx diversity, the transmit modulation quality requirements are specified at each transmit antenna connector.The transmit modulation quality is specified in terms of:

- Error Vector Magnitude (EVM) for the allocated resource blocks (RBs)

- EVM equalizer spectrum flatness derived from the equalizer coefficients generated by the EVM measurement process

- Carrier leakage (caused by IQ offset)

- In-band emissions for the non-allocated RB

In case the parameter 3300 or 3301 is reported from UE via *txDirectCurrentLocation* IE (as defined in TS 38.331 [7]), carrier leakage measurement requirement in clause 6.4D.2.2 and 6.4D.2.3 shall be waived, and the RF correction with regard to the carrier leakage and IQ image shall be omitted during the calculation of transmit modulation quality.

6.4G.2.1 Error Vector Magnitude

For UE supporting Tx diversity, the Error Vector Magnitude requirements specified in Table 6.4.2.1-1 which is defined in clause 6.4.2.1 apply at each transmit antenna connector. The total EVM requirement is derived based on the measurement at each antenna connector according to Annex F.8.

6.4G.2.2 Carrier leakage

For UE supporting Tx diversity, the Relative Carrier Leakage Power requirements specified in Table 6.4.2.2-1 which is defined in clause 6.4.2.2 apply at each transmit antenna connector.

6.4G.2.3 In-band emissions

For UE supporting Tx diversity, the In-band Emission requirements specified in Table 6.4.2.3-1 which is defined in clause 6.4.2.3 apply at each transmit antenna connector.

6.4G.2.4 EVM equalizer spectrum flatness for Tx Diversity

For UE supporting Tx diversity, the EVM Equalizer Spectrum Flatness requirements specified in Table 6.4.2.4-1 and Table 6.4.2.4-2 which are defined in clause 6.4.2.4 apply at each transmit antenna connector.

### **<Next Change>**

## 6.5G Output RF spectrum emissions for Tx Diversity

### 6.5G.1 Occupied bandwidth for Tx Diversity

For UE supporting Tx diversity, the requirements for occupied bandwidth apply to the transmitted spectrum as measured as the sum of the power from all UE transmit antenna connectors. The occupied bandwidth is defined as the bandwidth containing 99 % of the total integrated mean power of the transmitted spectrum on the assigned channel at each transmit antenna connector.

### 6.5G.2 Out of band emission for Tx Diversity

For UE supporting Tx diversity, the requirements for Out of band emissions resulting from the modulation process and non-linearity in the transmitters apply to the sum of the emissions from all UE transmit antenna connectors.

If UE indicates IE [*txDiversity-r16*], Adjacent Channel Leakage power Ratio (ACLR) is defined as the ratio of sum of the filtered mean power at each antenna connector centred on the assigned channel frequency to sum of the filtered mean power at each antenna connector centred on an adjacent channel frequency.

### 6.5G.3 Spurious emission for Tx Diversity

For UE supporting Tx diversity, the requirements for Spurious emissions which are caused by unwanted transmitter effects such as harmonics emission, parasitic emissions, intermodulation products and frequency conversion products apply to the sum of the emissions from all UE transmit antenna connectors.

### 6.5G.4 Transmit intermodulation for Tx Diversity

For UE supporting Tx diversity, the transmit intermodulation requirements are specified at each transmit antenna connector and the wanted signal is defined as the sum of output power from all UE transmit antenna connectors.

### **<Next Change>**

# F.8 EVM measurement for dual Tx

For UE with dual transmission antennas, if UE indicates IE [*txDiversity-r16*], EVM is measured at each antenna connector to get EVM1 and EVM2, and the total EVM is calculated by values of EVM1 and EVM2 with weighting factor of linear power at each antenna connector.

where P1 and P2 denote the linear power measured at each antenna connector respectively.

## **<End of Change>**