Draft

परीक्षण निर्देशिका
टीईसी ३५२११:२०२६

TEST GUIDE
TEC 35211:2026

for

निष्क्रिय वितरित एंटीना प्रणाली

(मानक सं :टीईसी ३५२१०:२०२६)

Passive Distributed Antenna System

(Standard No.: TEC 35210:2026)

ISO 9001:2015

दूरसंचार अभियांत्रिकी केंद्र
खुर्शीदलाल भवन, जनपथ, नई दिल्ली-११०००१, भारत
TELECOMMUNICATION ENGINEERING CENTRE
KHURSHIDLAL BHAWAN, JANPATH, NEW DELHI–110001, INDIA
www.tec.gov.in

Release 1: Month, 2026

FOREWORD

Telecommunication Engineering Centre (TEC) is the technical arm of Department of Telecommunications (DOT), Government of India. Its activities include:

- Framing of TEC Standards for Generic Requirements for a Product/Equipment, Standards for Interface Requirements for a Product/Equipment, Standards for Service Requirements & Standard document of TEC for Telecom Products and Services
- Formulation of Essential Requirements (ERs) under Mandatory Testing and Certification of Telecom Equipment (MTCTE)
- Field evaluation of Telecom Products and Systems
- Designation of Conformity Assessment Bodies (CABs)/Testing facilities
- Testing & Certification of Telecom products
- Adoption of Standards
- Support to DoT on technical/technology issues

For the purpose of testing, four Regional Telecom Engineering Centers (RTECs) have been established which are located at New Delhi, Bangalore, Mumbai, and Kolkata.

ABSTRACT

This document enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance of Passive Distributed Antenna System (Passive DAS) as per TEC Standard for Generic Requirements (GR) No. TEC 35210:2026.

CONTENTS

A. HISTORY SHEET

S.No.	Standard / document No.	Title	Remarks
1.	TEC 35211: 2026	Test Guide of Passive Distributed Antenna System	First Issue

B. INTRODUCTION

This document enumerates detailed test schedule and procedure for evaluating conformance / functionality / requirements / performance of Passive Distributed Antenna System as per standard for Generic Requirements No. TEC 35210:2026.

C. General information:

Sn.	General Information	Details *(to be filled by testing team)*	
1	Name and Address of the Applicant		
2	Date of Registration		
3	Name and No. of TEC Standard/Applicant's Spec. against which the approval sought		
4	Details of Equipment		
	Type of Equipment	Model No.	Serial No.
(i)			
(ii)			
5	Any other relevant Information:-		

D. Testing team: *(to be filled by testing team)*

S.No.	Name	Designation	Organization	Signature
1.				
2.				
3.				
4.				
5.				

E. List of the Test Instruments:

S.No.	Name of the test instrument	Make / Model *(to be filled by testing team)*	Validity of calibration *(to be filled by testing team)*
1.			dd/mm/yyyy
2.			
3.			
4.			
5.			
6.			
7.			
8.			

F. Equipment Configuration Offered: *(to be filled by testing team)*

(a) **<Equipment/product name> Configuration:**

S.No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

(b) **<Other equipment name> Configuration:**

S.No.	Item	Details	Remarks

Relevant information like No. of cards, ports, slots, interfaces, size etc. may be filled as applicable for the product

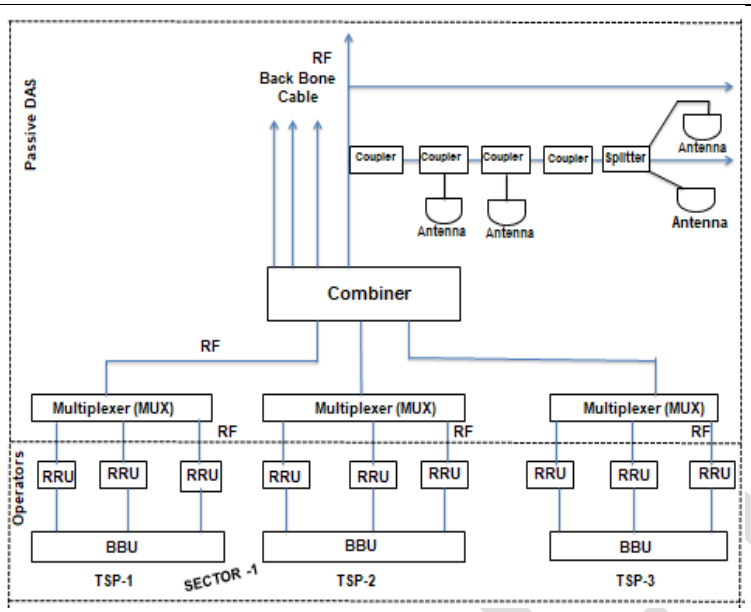
G. Equipment/System Manuals: *(to be filled by testing team)*

Availability of Maintenance manuals, Installation manual, Repair manual & User Manual etc. **(Y/N)**

H. Clause-wise Test Type and Test No.:

Clause No.	Clause	Type of Test / Test No. etc.
1.0	**Introduction**	
1.1	Mobile networks supporting multiple frequency bands and radio access technologies (2G/3G/4G/5G) require dedicated indoor/in-building solutions to address signal attenuation caused by indoor and semi-enclosed environments.	Information.
1.2	A Passive Distributed Antenna System (Passive DAS) is a cabling-based coverage solution that distributes RF signals without the use of amplification, through passive components such as combiners, splitters, couplers, RF feeder cables, and service antennas. It comprises operator signal input interfaces and a passive RF distribution network terminating at service antennas, enabling multi-operator and multi-band coverage across licensed mobile frequency bands while maintaining signal integrity within passive link budget limits.	Information.
1.3	This Generic Requirement (GR) specifies the functional, technical, operational, quality, interoperability, environmental, and interface requirements for Passive DAS deployments in commercial buildings, public venues, transportation hubs, campuses, residential complexes, and similar environments.	Information.
2.0	**Description** A Passive Distributed Antenna System (PDAS) is a non-amplified RF distribution system that passively delivers	1. Submit an undertaking from the Supplier / Manufacturer / OEM

	radio frequency signals from one or more mobile network operators to multiple service antennas using RF/coaxial feeder cables and passive RF components. The system operates without electronic signal processing or active gain within the distribution network. Operator signals are combined and routed through a passive RF backbone using components such as multiplexers, combiners, splitters, and couplers. RF power distribution is carried out in accordance with the system RF design and link budget, with signal levels controlled through fixed passive losses. The PDAS supports multi-operator and multi-band operation in a carrier-agnostic manner and is suitable for in-building environments where coverage requirements can be met through passive RF distribution. The passive architecture ensures reliable operation, predictable performance, and low operational and maintenance complexity. By appropriate deployment of directional and omnidirectional antennas, the PDAS provides uniform indoor coverage while maintaining RF isolation and impedance continuity. The system is suitable for small to medium-scale in-building deployments where signal distribution can be achieved within permissible passive link budget limits.	that PDAS Supports multi-operator and multi band operation in carrier-agnostic manner. 2. Submit block diagram illustrating RF signal flow from operator input interfaces through passive components (multiplexers, combiners, splitters, couplers, RF feeder cables) up to service antennas.
2.1	Architecture of Passive Distributed Antenna System	Submit system architecture diagram of Passive DAS.

		
2.2	**Network Elements of the Passive Distributed Antenna System (Passive DAS)** A. The Passive DAS shall consist of the following major network elements required to support end-to-end RF signal aggregation, distribution, transport, and radiation within the intended coverage area. The Passive DAS may have the following network elements (a) Multiplexer i. Diplexers ii. Triplexer iii. Pentaplexer (b) Combiner i. Hybrid(2X2) ii. Hybrid(4x4) (c) Coupler(Directional) i. 6db	A. 1. Submit detailed description of all network elements constituting the Passive DAS, including multiplexers, combiners, directional couplers, power splitters, antennas, and associated passive RF accessories. 2. Submit system block diagram clearly indicating interconnection, RF signal flow, and

	ii. 10db iii. 15db (d) Power Splitter i. Two way ii. Three way iii. Four way (e) Antenna i. Panel(SISO/MIMO-2x2) ii. Omnidirectional(SISO/MIMO-2x2) (f) Accessories as per requirement (RF cable, Terminators, Adapters, Jumper, Connector, etc) B. **Operating Frequency Range**- The system shall operate over a frequency range of 600 MHz to 4 GHz, and this range shall be supported and compatible across all network elements of the Passive DAS. The commercial use of frequency and power limits shall be governed as per NFAP 2025 and its amendments from time to time	distribution topology across all passive network elements up to service antennas. 3. Physical Check of Network elements as per submissions at A (1) & A (2) above. B. Test Case - 1
2.2.1	**Multiplexer (MUX)** The Multiplexer (MUX) in a Passive DAS is a passive RF band-management network element that combines or separates multiple frequency bands from one or more operators before distribution within the DAS. It enables efficient handling of different radio access technologies and frequency ranges while maintaining high isolation between bands to prevent interference and intermodulation.	Submit product datasheets of the respective Multiplexer units (Diplexer, Triplexer, Pentaplexer) indicating compliance with specified technical parameters

<table>
<tr><td></td><td>This includes diplexers, triplexers, and pentaplexers, which manage two, three, or five frequency bands, respectively. All such devices operate without external power and preserve RF signal integrity by introducing minimal insertion loss and distortion, ensuring reliable multi-band, multi-operator performance throughout the Passive DAS infrastructure.</td><td>including insertion loss, isolation, VSWR, PIM, and power handling.</td></tr>
<tr><td>2.2.1.1</td><td>Technical Specifications - Diplexer, DIN-Female

<table><tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr><tr><td>1</td><td>GENERAL SPECIFICATIONS</td><td></td></tr><tr><td>1.1</td><td>Interface</td><td>DIN-Female</td></tr><tr><td>1.2</td><td>Mounting Type</td><td>Wall/Pole</td></tr><tr><td>2</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr><tr><td>2.1</td><td>Isolation (dB)</td><td>≤50</td></tr><tr><td>2.2</td><td>Insertion Loss(dB)</td><td>≤0.5 ± 0.1</td></tr><tr><td>2.3</td><td>VSWR</td><td>≤1.25</td></tr><tr><td>2.4</td><td>Impedance (Ω)</td><td>50 ± 2</td></tr><tr><td>2.5</td><td>PIM @ 2x43dBm (dBc)</td><td>≤-150</td></tr><tr><td>2.6</td><td>Power Handling (W)</td><td>100/Port</td></tr></table></td><td rowspan="2">For clauses 2.2.1.1, 2.2.1.2 and 2.2.1.3 as applicable.

1. Test Case – 2
2. Submit declaration confirming conformance of the respective Multiplexer units to applicable technical specifications defined under Clause 2.2.2.1, 2.2.1.2 and 2.2.1.3.
3. An undertaking to be given for the compliance to IEC 62037, IEC 61169 and other</td></tr>
<tr><td>2.2.1.2</td><td>Technical Specifications – Triplexer

<table><tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr><tr><td>1</td><td>GENERAL</td><td></td></tr></table></td></tr>
</table>

		SPECIFICATIONS		equivalent industry standards wherever applicable if NABL/TEC accredited/ designated lab is not available.
	1.1	Interface	DIN-Female	
	2	ELECTRICAL SPECIFICATIONS		
	2.1	Isolation (dB)	≤50	
	2.2	Insertion Loss(dB)	0.7 ± 0.1	
	2.3	VSWR	≤1.25	
	2.4	Impedance (Ω)	50 ± 2	
	2.5	PIM @ 2x43dBm (dBc)	≤-150	
	2.6	Power Handling (W)	100/Port	
2.2.1.3	**Technical Specifications - Pentaplexer, DIN-Female**			
	S. No.	**Parameter**	**Specification**	
	1	GENERAL SPECIFICATIONS		
	1.1	Interface	DIN-Female	
	2	ELECTRICAL SPECIFICATIONS		
	2.1	Isolation (dB)	≤50	
	2.2	Insertion Loss(dB)	≤0.5 ± 0.2	
	2.3	VSWR	≤1.3	
	2.4	Impedance (Ω)	50 ± 2	
	2.5	PIM @ 2x43dBm (dBc)	≤-157 ± 2	
	2.6	Power Handling (W)	200/Port	
2.2.2	**Combiner** The Combiner shall aggregate RF signals from multiple			Submit detailed product datasheet of

<table>
<tr><td></td><td>operators and/or frequency bands into a combined RF output for distribution over a common RF backbone. It shall support simultaneous multi-operator signal distribution while ensuring adequate isolation between input ports to minimize interference. The combiner shall maintain signal linearity and impedance characteristics across the supported operating frequency range and shall be suitable for continuous passive operation in indoor Passive DAS deployments.</td><td>the respective Hybrid Combiner (2×2 / 4×4) indicating compliance with specified electrical and mechanical parameters including insertion/combining loss, isolation, VSWR, PIM, impedance, and power handling.</td></tr>
<tr><td>2.2.2.1</td><td>Technical Specifications - Hybrid Combiner, 2x2
<table>
<tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr>
<tr><td>1</td><td>GENERAL SPECIFICATIONS</td><td></td></tr>
<tr><td>1.1</td><td>Interface</td><td>DIN-Female</td></tr>
<tr><td>1.2</td><td>Number of Ports</td><td>2 Input & 2 Output</td></tr>
<tr><td>2</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>2.1</td><td>Impedance (Ω)</td><td>50</td></tr>
<tr><td>2.2</td><td>VSWR</td><td>≤1.30</td></tr>
<tr><td>2.3</td><td>PIM @ 2x43dBm (dBc)</td><td>≤-150</td></tr>
<tr><td>2.4</td><td>Combining Loss (dB)</td><td>3.9 ± 0.2</td></tr>
<tr><td>2.5</td><td>Isolation (dB)</td><td>≥23</td></tr>
<tr><td>2.6</td><td>Power Handling,</td><td>300</td></tr>
</table></td><td>For clauses 2.2.2.1, 2.2.2.2 as applicable.

1. Test Case – 3
2. Submit declaration confirming conformance of the respective Combiner to applicable technical specifications as defined in Clause 2.2.2.1 and 2.2.2.2.
3. An undertaking to be given for the compliance to IEC 62037, IEC 61169 and other equivalent industry standards</td></tr>
</table>

<table>
<tr><td></td><td><table><tr><td></td><td>Average (W)</td><td></td></tr></table></td><td rowspan="2">wherever applicable if NABL/TEC accredited/ designated lab is not available.</td></tr>
<tr><td>2.2.2.2</td><td>Technical Specifications - Hybrid Combiner, 4x4

<table><tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr><tr><td>1</td><td>GENERAL SPECIFICATIONS</td><td></td></tr><tr><td>1.1</td><td>Interface</td><td>DIN-Female</td></tr><tr><td>1.2</td><td>Number of Ports</td><td>4 Input & 4 Output</td></tr><tr><td>2</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr><tr><td>2.1</td><td>Impedance (Ω)</td><td>50 ± 2</td></tr><tr><td>2.2</td><td>PIM @ 2x43dBm (dBc)</td><td>≤-150</td></tr><tr><td>2.3</td><td>VSWR</td><td>≤1.30</td></tr><tr><td>2.4</td><td>Combining Loss (dB)</td><td>7.4 ± 0.2</td></tr><tr><td>2.5</td><td>Isolation (dB)</td><td>≥23</td></tr><tr><td>2.6</td><td>Power Handling (W)</td><td>100/Port</td></tr></table></td></tr>
<tr><td>2.2.3</td><td>Coupler
The Directional Coupler is a critical passive network element in a Passive Distributed Antenna System (PDAS), designed to extract a predefined portion of RF power from the main backbone cable while allowing the majority of the signal to continue uninterrupted along the primary transmission path. This functionality enables controlled distribution of signal power over</td><td>Submit detailed product datasheet of the respective Directional Couplers (6 dB / 10 dB / 15 dB) indicating compliance with specified electrical parameters including coupling loss,</td></tr>
</table>

<table>
<tr><td></td><td>extended cable runs to multiple remote antenna locations, ensuring balanced coverage across different areas within a building or facility.
Directional couplers with standard coupling values such as 6 dB, 10 dB, and 15 dB are typically employed to achieve the required level of signal tapping based on coverage and design requirements.</td><td>through loss, VSWR, PIM, impedance, and power handling.</td></tr>
<tr><td>2.2.3.1</td><td>Technical Specifications - Directional Coupler – 06dB

<table><tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr><tr><td>1</td><td>GENERAL SPECIFICATIONS</td><td></td></tr><tr><td>1.1</td><td>Interface</td><td>N-Female</td></tr><tr><td>2</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr><tr><td>2.1</td><td>Impedance (Ω)</td><td>50</td></tr><tr><td>2.2</td><td>PIM @ 2x43dBm (dBc)</td><td>≤-150</td></tr><tr><td>2.3</td><td>Coupling Port Loss (dB)</td><td>6.0 ± 0.9</td></tr><tr><td>2.4</td><td>Through Port Loss (dB)</td><td>1.7 ± 0.1</td></tr><tr><td>2.5</td><td>VSWR</td><td>≤1.25</td></tr><tr><td>2.6</td><td>Power Handling (W)</td><td>200</td></tr></table></td><td>For clauses 2.2.3.1, 2.2.3.2 and 2.2.3.3 as applicable.

1. Test Case – 4
2. Submit declaration confirming conformance of the respective Directional Coupler(s) to applicable technical specifications as defined in Clause 2.2.3.1, 2.2.3.2, and 2.2.3.3.
3. An undertaking to</td></tr>
</table>

2.2.3.2 **Technical Specifications - Directional Coupler – 10dB**

S. No.	Parameter	Specification
1	GENERAL SPECIFICATIONS	
1.1	Interface	N-Female
2	ELECTRICAL SPECIFICATIONS	
2.1	Impedance (Ω)	50
2.2	PIM @ 2x43dBm (dBc)	≤-150
2.3	Coupling Port Loss (dB)	10.0 ± 1.0
2.4	Through Port Loss (dB)	1.0 ± 0.1
2.5	VSWR	≤1.25
2.6	Power Handling (W)	200

2.2.3.3 **Technical Specifications - Directional Coupler – 15dB**

S. No.	Parameter	Specification
1	GENERAL SPECIFICATIONS	
1.1	Interface	N-Female
2	ELECTRICAL SPECIFICATIONS	
2.1	Impedance (Ω)	50
2.2	PIM @ 2x43dBm (dBc)	≤-150
2.3	Coupling Port Loss (dB)	15.0 ± 1.0
2.4	Through Port Loss	0.5 ± 0.1

be given for the compliance to IEC 62037, IEC 61169 and other equivalent industry standards wherever applicable if NABL/TEC accredited/ designated lab is not available.

<table>
<tr><td></td><td>
<table>
<tr><td></td><td>(dB)</td><td></td></tr>
<tr><td>2.5</td><td>VSWR</td><td>≤1.25</td></tr>
<tr><td>2.6</td><td>Power Handling (W)</td><td>200</td></tr>
</table>
</td><td></td></tr>
<tr><td>2.2.4</td><td>Splitter
The Splitter is a passive RF network element in a Passive DAS used to divide an input RF signal into multiple output paths for distribution to downstream antennas or RF branches. It shall provide either equal or designed power division while preserving RF signal integrity and maintaining proper impedance matching at all ports to minimize losses and reflections within the DAS network. Any unused output ports shall be terminated with suitable RF loads to ensure stable system operation and to prevent degradation of overall Passive DAS performance.</td><td>Submit detailed product datasheet of the respective Power Splitters (2-way / 3-way / 4-way) indicating compliance with specified electrical parameters including dividing loss, in-band ripple, VSWR, PIM, impedance, and power handling.</td></tr>
<tr><td>2.2.4.1</td><td>Technical Specifications - Power Splitter, Two-Way
<table>
<tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr>
<tr><td>1</td><td>GENERAL SPECIFICATIONS</td><td></td></tr>
<tr><td>1.1</td><td>Interface</td><td>N-Female</td></tr>
<tr><td>2</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>2.1</td><td>Impedance (Ω)</td><td>50</td></tr>
<tr><td>2.2</td><td>PIM @ 2x43dBm (dBc)</td><td>≤-150</td></tr>
<tr><td>2.3</td><td>Dividing Loss (dB)</td><td>3.5 ± 0.2</td></tr>
</table>
</td><td>For clauses 2.2.4.1, 2.2.4.2 and 2.2.4.3 as applicable.

1. Test Case – 5
2. Submit declaration confirming conformance of the respective Power Splitter(s) to applicable technical specifications as</td></tr>
</table>

		2.4	In-band Ripple (dB)	≤0.3
		2.5	VSWR	≤1.25
		2.6	Power Handling (W)	300
2.2.4.2	**Technical Specifications - Power Splitter, Three-Way**			
		S. No.	**Parameter**	**Specification**
		1	GENERAL SPECIFICATIONS	
		1.1	Interface	N-Female
		2	ELECTRICAL SPECIFICATIONS	
		2.1	Impedance (Ω)	50
		2.2	PIM @ 2x43dBm (dBc)	≤-150
		2.3	Dividing Loss (dB)	5.3 ± 0.2
		2.4	In-band Ripple (dB)	≤0.3
		2.5	VSWR	≤1.25
		2.6	Power Handling (W)	300
2.2.4.3	**Technical Specifications - Power Splitter, Four-Way**			
		S. No.	**Parameter**	**Specification**
		1	GENERAL SPECIFICATIONS	
		1.1	Interface	N-Female

defined in Clause 2.2.4.1, 2.2.4.2, and 2.2.4.3.

3. An undertaking to be given for the compliance to IEC 62037, IEC 61169 and other equivalent industry standards wherever applicable if NABL/TEC accredited/ designated lab is not available.

	2	ELECTRICAL SPECIFICATIONS	
	2.1	Impedance (Ω)	50
	2.2	PIM @ 2x43dBm (dBc)	≤-150
	2.3	Dividing Loss (dB)	6.5 ± 0.2
	2.4	In-band Ripple (dB)	≤0.3
	2.5	VSWR	≤1.25
	2.6	Power Handling (W)	300
2.2.5	**Antennas** The antenna subsystem in a Passive DAS converts RF signals from the distribution network into electromagnetic fields for reliable indoor coverage. Antennas shall support multi-technology operation (2G/3G/4G/5G), comply with in building wireless standards, provide appropriate radiation patterns and polarization, and ensure low passive intermodulation (PIM) with broad frequency band support to maintain signal quality.		Submitted detail product sheets of the provided Antennas viz Panel Antenna, Omnidirectional Antenna.
2.2.5.1	**Panel Antenna** A Panel Antenna is a directional radiating element in a Passive DAS that provides controlled RF coverage within a defined sector. It is used in areas requiring focused radiation, such as corridors, tunnels, platform edges, and linear indoor environments, to optimize coverage and limit interference. Panel antennas support broadband operation across relevant cellular and wireless service bands and are configured in SISO (Single Input Single Output) or MIMO		For clauses 2.2.5.1, 2.2.5.1.1 and 2.2.5.1.2 as applicable. 1. Test Case – 6 2. Submit declaration confirming conformance of the respective Panel Antenna to

<table>
<tr><td></td><td>(Multiple Input Multiple Output) arrangements to enhance spectral efficiency, throughput, and link reliability for modern multi carrier systems. In MIMO configurations, multiple ports and polarization diversity improve channel capacity and resilience to multipath fading, which is essential for 4G LTE and 5G NR performance in dense indoor settings.</td><td rowspan="2">applicable technical specifications as defined in Clause 2.2.5.1, 2.2.5.1.1, and 2.2.5.1.2.
3. An undertaking to be given for the compliance to IEC 62037, IEC 61169 and other equivalent industry standards wherever applicable if NABL/TEC accredited / designated lab is not available.</td></tr>
<tr><td>2.2.5.1.1</td><td>Technical Specifications - Panel Antenna (Directional), SISO

<table>
<tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr>
<tr><td>1</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>1.1</td><td>Typical Gain (dBi)</td><td>5.0 ± 0.5</td></tr>
<tr><td>1.2</td><td>Horizontal Beamwidth (°)</td><td>95 ± 10</td></tr>
<tr><td>1.3</td><td>Vertical Beamwidth (°)</td><td>90 ± 10</td></tr>
<tr><td>1.4</td><td>Front to Back Ratio (dB)</td><td>≥10</td></tr>
<tr><td>1.5</td><td>VSWR</td><td>≤2.0 ± 0.2</td></tr>
<tr><td>1.6</td><td>Polarization</td><td>Vertical</td></tr>
<tr><td>1.7</td><td>Impedance (Ω)</td><td>50</td></tr>
<tr><td>1.8</td><td>PIM @ 2x43 dBm (dBc)</td><td>≤–150</td></tr>
<tr><td>1.9</td><td>Maximum Input Power (W)</td><td>50</td></tr>
<tr><td>2</td><td>MECHANICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>2.1</td><td>Antenna Array</td><td>SISO</td></tr>
<tr><td>2.2</td><td>Connector Type</td><td>N-Female with Pigtail</td></tr>
</table>
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<tr>
<td>2.2.5.1.2</td>
<td>Technical Specifications - Panel Antenna (Directional), 2X2 MIMO
<table>
<tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr>
<tr><td>1</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>1.1</td><td>Typical Gain (dBi)</td><td>5.0 ± 0.5</td></tr>
<tr><td>1.2</td><td>Horizontal Beamwidth (°)</td><td>95 ± 10</td></tr>
<tr><td>1.3</td><td>Vertical Beamwidth (°)</td><td>80 ± 10</td></tr>
<tr><td>1.4</td><td>Front to Back Ratio (dB)</td><td>≥7</td></tr>
<tr><td>1.5</td><td>VSWR</td><td>≤2.0</td></tr>
<tr><td>1.1</td><td>Polarization</td><td>±45°</td></tr>
<tr><td>1.2</td><td>Impedance (Ω)</td><td>50</td></tr>
<tr><td>1.3</td><td>PIM @ 2x43 dBm (dBc)</td><td>≤–150</td></tr>
<tr><td>1.4</td><td>Maximum Input Power (W)</td><td>50</td></tr>
<tr><td>2</td><td>MECHANICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>2.1</td><td>Antenna Array</td><td>2X2 MIMO</td></tr>
<tr><td>2.2</td><td>Connector Type</td><td>N-Female with Pigtail</td></tr>
</table></td>
<td></td>
</tr>
<tr>
<td>2.2.5.2</td>
<td>Omnidirectional Antenna
The Omnidirectional Antenna provides uniform RF radiation in the horizontal plane, suitable for large, open indoor areas such as halls, lobbies, and open spaces where broad coverage is needed. Ensures even RF distribution in all horizontal directions from a central location for consistent signal strength.</td>
<td>For clauses 2.2.5.2, 2.2.5.2.1, 2.2.5.2.2 and 2.2.5.2.3 as applicable.
1. Test Case – 7
2. Submit declaration</td>
</tr>
</table>

<table>
<tr><td></td><td>Omnidirectional antennas in Passive DAS also support broadband frequency ranges and can be built for SISO or MIMO configurations, enabling simultaneous support for multiple signal paths and improving overall system capacity and performance. MIMO omnidirectional antennas particularly benefit capacity and spectral efficiency in environments with high user density.</td><td rowspan="2">confirming conformance of the respective Omnidirectional Antenna to applicable technical specifications as defined in Clause 2.2.5.2, 2.2.5.2.1, 2.2.5.2.2 and 2.2.5.2.3.
3. An undertaking to be given for the compliance to IEC 62037, IEC 61169 and other equivalent industry standards wherever applicable if NABL/TEC accredited / designated lab is not available.</td></tr>
<tr><td>2.2.5.2.1</td><td>Technical Specifications – Indoor Omnidirectional Antenna, SISO
<table>
<tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr>
<tr><td>1</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>1.1</td><td>Typical Gain (dBi)</td><td>2.0 ± 0.5</td></tr>
<tr><td>1.2</td><td>Horizontal Beamwidth (°)</td><td>360 each band</td></tr>
<tr><td>1.3</td><td>Vertical Beamwidth (°)</td><td>90 ± 5</td></tr>
<tr><td>1.4</td><td>VSWR</td><td>≤2.0 ± 0.2</td></tr>
<tr><td>1.5</td><td>Polarization</td><td>Vertical</td></tr>
<tr><td>1.6</td><td>Impedance (Ω)</td><td>50</td></tr>
<tr><td>1.7</td><td>PIM @ 2x43 dBm (dBc)</td><td>≤–150</td></tr>
<tr><td>1.8</td><td>Maximum Input Power (W)</td><td>50</td></tr>
<tr><td>2</td><td>MECHANICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>2.1</td><td>Antenna Array</td><td>SISO</td></tr>
<tr><td>2.2</td><td>Connector Type</td><td>N-Female with Pigtail</td></tr>
</table></td></tr>
</table>

2.2.5.2.2	**Technical Specifications-Indoor Omnidirectional Antenna, 2X2 MIMO**	

S. No.	Parameter	Specification
1	ELECTRICAL SPECIFICATIONS	
1.1	Typical Gain (dBi)	2.0 ± 0.5
1.2	Horizontal Beamwidth (°)	360 each band
1.3	Vertical Beamwidth (°)	95 ± 5
1.4	VSWR	2.0 ± 0.2
1.5	Polarization	Horizontal
1.6	Impedance (Ω)	50 ± 0.2
1.7	PIM @ 2x43 dBm (dBc)	≤–150
1.8	Maximum Input Power (W)	50
2	MECHANICAL SPECIFICATIONS	
2.1	Antenna Array	2x2 MIMO
2.2	Connector Type	N-Female with Pigtail

<table>
<tr>
<td>2.2.5.2.3</td>
<td>Technical Specifications - High Gain Antenna
<table>
<tr><th>S. No.</th><th>Parameter</th><th>Specification</th></tr>
<tr><td>1</td><td>GENERAL SPECIFICATIONS</td><td></td></tr>
<tr><td>1.1</td><td>Polarization</td><td>Vertical</td></tr>
<tr><td>1.2</td><td>Impedance (Ω)</td><td>50</td></tr>
<tr><td>1.3</td><td>Connector Type</td><td>N-Female</td></tr>
<tr><td>2</td><td>ELECTRICAL SPECIFICATIONS</td><td></td></tr>
<tr><td>2.1</td><td>Gain (dBi)</td><td>10 ± 1</td></tr>
<tr><td>2.2</td><td>VSWR</td><td><2.0 ± 0.2</td></tr>
<tr><td>2.3</td><td>Polarization</td><td>Vertical</td></tr>
<tr><td>2.4</td><td>Front to Back Ratio (dB)</td><td>>20 / >23</td></tr>
<tr><td>2.5</td><td>PIM, 3rd Order @ 2x20W (dBc)</td><td>≤–150</td></tr>
<tr><td>2.6</td><td>Horizontal Beamwidth (°)</td><td>80 ± 5 / 65 ± 5</td></tr>
<tr><td>2.7</td><td>Vertical Beamwidth (°)</td><td>35 ± 5</td></tr>
<tr><td>2.8</td><td>Max. Power (W)</td><td>100</td></tr>
</table></td>
<td></td>
</tr>
<tr>
<td>2.2.6</td>
<td>Passive DAS Accessories

Following accessories may be deployed with network elements of passive DAS as per requirement such that the above-stated technical/operational performance requirements are complied.

2.2.1 RF Cable (½” Low Loss Corrugated RF Cable and ⅞” Low Loss Corrugated RF Cable)
2.2.1 Terminator (50W, 100W)</td>
<td>1. Submit detailed product datasheets of all Passive DAS accessories including RF cables, terminators, adaptors, jumpers, and connectors, indicating compliance with specified electrical and mechanical</td>
</tr>
</table>

	2.2.1 Adaptors (Right-Angled Adaptors, N(M)-N(F)) 2.2.1 Jumper (1/2" SF Cable – 02 Meter, D(M)-4(M) / D(M)-N(F) / D(M)-N(M) / N(M)-N(M)) 2.2.1 Connector (N-Male Straight Connector for 7/8" RF Cable / 1-1/4" RF Cable / ½" RF Cable) Note#1- This list is illustrative not exhaustive	parameters such as impedance, insertion loss, VSWR, PIM, power handling, and construction characteristics. 2. Submit declaration confirming conformance of all accessories to the applicable technical specifications and relevant international standards, including IEC 61169 (RF connectors), IEC 62037 (Passive Intermodulation), and other equivalent industry standards wherever applicable, ensuring compatibility with Passive DAS deployment requirements.
2.3	**Documentation** Detailed documentation in English shall be provided, including: a. Self-explanatory user manual giving details of all	Required documents to be provided by OEM / Manufacturer/ Supplier.

	functions, facilities and Procedures. b. Set-up and configuration parameters and procedures. c. Trouble shooting guide including fault dictionary. Additionally, the documentation shall also be made available in soft copy form in both Hindi and English.	
3.0	**Quality Requirements** The manufacturer of the DAS equipment (Head-end, Remote Units, Distribution Units, Power Modules, and associated components) shall have a valid ISO 9001:2015 quality management certification or any equivalent international quality standard.	For clauses 3.0, 3.1.1, 3.1.2 and 3.1.3 as Applicable. Undertaking from OEM / Manufacturer/ Supplier.
3.1.1	For coverage, the target RSRP shall be better than –110 dBm for all technology. However, this may be reviewed in tender requirements.	
3.1.2	The DAS shall meet the minimum radio service quality requirements, including RSRP, SINR, and RSRQ performance for 2G, 3G, 4G, and 5G services at the user equipment level across the declared coverage area. Compliance shall be verified during acceptance and performance testing. However, these quality requirements may be further improved as per the mutual requirements of the purchaser/procurer and the mobile service operator	
3.1.3	The supplier shall ensure availability of maintenance support, spare modules, and software updates for the declared product life cycle.	
4.0	**EMI/EMC Requirements**	Information.

	The equipment in the Distributed Antenna System (DAS) shall conform to the TEC Standards on EMI/EMC as applicable for telecommunication equipment, as prescribed in the relevant TEC document "Electromagnetic Compatibility Standard for Telecommunication Equipment", TEC 11016:2016, (Old Document No.: TEC/SD/DD/EMC-221/05/OCT-16).	
1.	Conducted and Radiated Emission	Certificate(s) from accredited test labs are to be submitted.
2.	Immunity to Electrostatic discharge: Contact discharge level 2 {± 4 kV}	Certificate(s) from accredited test labs are to be submitted.
3.	Immunity to Electrostatic discharge: Air discharge level 3 {± 8 kV}	Certificate(s) from accredited test labs are to be submitted.
4.	Immunity to radiated RF: a) Radio Frequency: 80 MHz to 1 GHz, Electromagnetic field: 3V/m b) Radio Frequency: 800 MHz to 960 MHz, Electromagnetic field: 10V/m¥ c) Radio Frequency: 1.4 GHz to 6 GHz, Electromagnetic field: 10V/m	Certificate(s) from accredited test labs are to be submitted.
5.	Immunity to fast transients (burst): Test Level 2: a) 1 kV for AC/DC power port b) 0. 5 kV for signal / control / data / telecom lines.	Certificate(s) from accredited test labs are to be submitted.

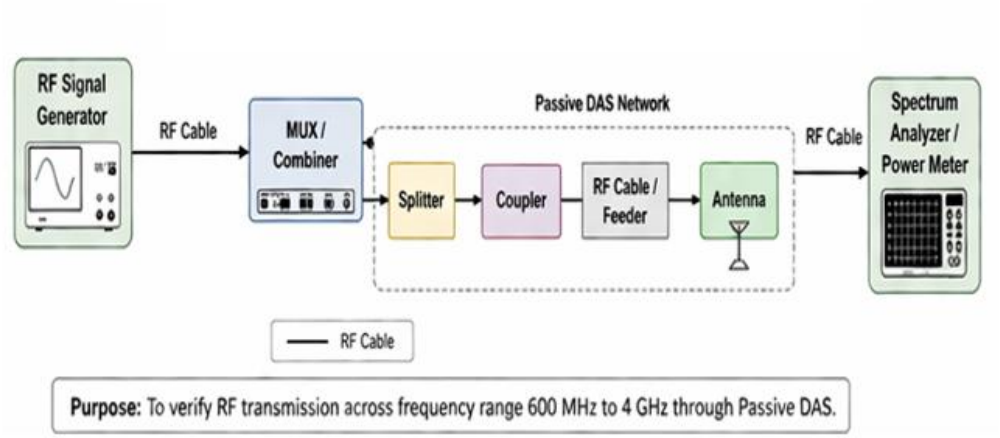
6.	Immunity to surges: AC/DC ports a) 2 kV peak open circuit voltage for line to ground b) 1kV peak open circuit voltage for line to line	Certificate(s) from accredited test labs are to be submitted.
7.	Immunity to surges: Telecom ports a) 2 kV peak open circuit voltage for line to ground coupling. b) 2 kV peak open circuit voltage for line-to-line coupling.	Certificate(s) from accredited test labs are to be submitted.
8.	Immunity to conducted disturbance induced by Radio frequency fields: Under the test level 2 {3 V r.m.s.} in the frequency range 150 kHz-80 MHz for AC / DC lines and Signal /Control/telecom lines.	Certificate(s) from accredited test labs are to be submitted.
9.	Immunity to voltage dips & short interruptions (applicable to only ac mains power input ports, if any): Limits: - a) a voltage dip corresponding to a reduction of the supply voltage of 30% for 500ms (i.e., 70% supply voltage for 500ms) b) a voltage dip corresponding to a reduction of the supply voltage of 60% for 200ms; (i.e.,40% supply voltage for 200ms) c) a voltage interruption corresponding to a reduction of supply voltage of > 95% for 5s. d) a voltage interruption corresponding to a reduction of supply voltage of >95% for 10ms.	Certificate(s) from accredited test labs are to be submitted.

10.	Immunity to voltage dips & short interruptions (applicable to only DC power input ports, if any): a) Voltage Interruption with 0% of supply for 10ms. b) Voltage Interruption with 0% of supply for 30ms, 100ms, 300ms and 1000ms. c) Voltage dip corresponding to 40% & 70% of supply for 10ms, 30 ms. d) Voltage dip corresponding to 40% & 70% of supply for 100ms, 300 ms and 1000 ms. e) Voltage variations corresponding to 80% and 120%of supply for 100 ms to 10s as per Table 1c of IEC 61000-4-29.	Certificate(s) from accredited test labs are to be submitted.
5.0	**Safety Requirements**	
5.1	The equipment shall conform to relevant safety requirements as per IS 10437 : 2019/ IEC 60215:2016 – "Radio Transmitting Equipment (Other than CPE)" - "Part 1: Safety requirements" as prescribed under Table no. 1 of the TEC document 'SAFETY REQUIREMENTS OF TELECOMMUNICATION EQUIPMENT": TEC10009: 2024.	Test Certificate(s) / reports from accredited test labs are to be submitted.
6.0	**Environmental Requirements**	
6.1	The Passive DAS equipment shall meet the following environmental specifications to ensure reliable operation under defined conditions:	Information.
6.1.1	The equipment shall meet the environmental requirements as per Category B of the TEC Standard for "Environmental Testing of Telecommunication Equipment", TEC14016:2010 (old no. QM-333 Issue March 2010	Test Certificate(s)/ report from accredited test labs are to be submitted. Also, an Undertaking to be submitted from the OEM

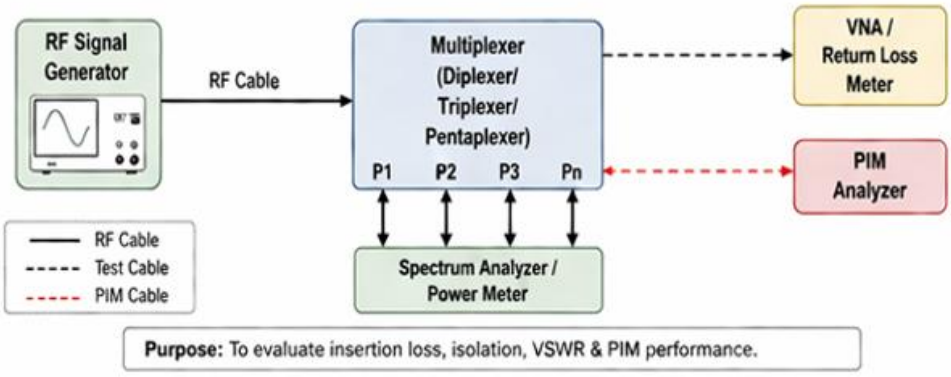
		/ Manufacturer/ Supplier towards compliance of this clause.
6.1.2	The equipment shall have a water-proofing rating of IP65.	Test Certificate(s)/ report from accredited test labs are to be submitted. Also, an Undertaking to be submitted from the OEM / Manufacturer/ Supplier towards compliance of this clause.
6.1.3	The equipment shall be suitable for both indoor and outdoor applications.	Undertaking from OEM / Manufacturer / Supplier.
7.0	**Interoperability Requirements**	
7.1	The Distributed Antenna System (DAS) shall meet the following interoperability requirements to support multi-operator, multi-band, multi-technology, and multi-vendor deployments:	Information.
7.1.1	Operator signals shall remain logically separated Across the DAS, ensuring independent and interference-free operation. *Note - The system shall support per-operator power control, including an output power of 20 Watt per RRU per operator, configurable attenuation settings, and resource allocation for efficient multi-operator performance. The installation site shall have sufficient and reliable electrical power/backup/grid supply etc to support continuous operation of the*	Physical Check

	RRU(s), including peak power consumption, with provision for redundancy where applicable)	

I. Test Setup & Procedures

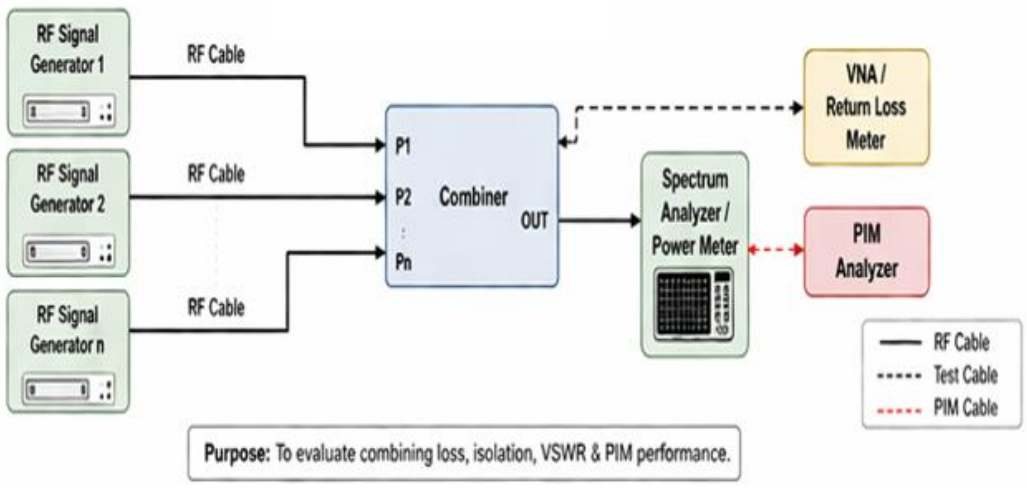
Test No.	Test Case – 1 (For clause 2.2 (B))
Test Details	**Operating Frequency Range-** The system shall operate over a frequency range of 600 MHz to 4 GHz, and this range shall be supported and compatible across all network elements of the Passive DAS. The commercial use of frequency and power limits shall be governed as per NFAP 2025 and its amendments from time to time
Test Setup	**TEST SETUP 1: Operating Frequency Range (Passive DAS Network)** 
Test Procedure	1. Configure the Passive DAS network using representative passive components including multiplexers, combiners, splitters, couplers, RF feeder cables, and service antennas as per system design. 2. Connect the RF Signal Generator to the input port of the Passive DAS network.

	3. Connect the Spectrum Analyzer or Power Meter at the output port (antenna end or designated RF output point). 4. Generate RF signals across the frequency range from 600 MHz to 4 GHz in sweep mode. 5. Measure and record the output signal levels at multiple frequency points across the operating band. 6. Verify signal continuity, insertion loss behaviour, and uniform response across the entire frequency range. 7. Confirm that all passive components support the declared frequency range without abnormal attenuation, impedance mismatch, or signal degradation.
Test Instruments Required	RF Signal Generator, Spectrum Analyzer / Power Meter, RF Cables, Connectors, Attenuators (if required)
Test Limits	The Passive DAS shall support RF signal transmission across the declared frequency range of 600 MHz to 4 GHz. All passive network elements shall operate within specified frequency limits and comply with applicable provisions of NFAP 2025.
Expected Results	The Passive DAS shall demonstrate stable RF signal transmission across the declared frequency range. Signal continuity shall be maintained across the band with predictable insertion loss characteristics and without abnormal attenuation, reflection, or distortion. The system shall comply with applicable frequency usage provisions as per NFAP.

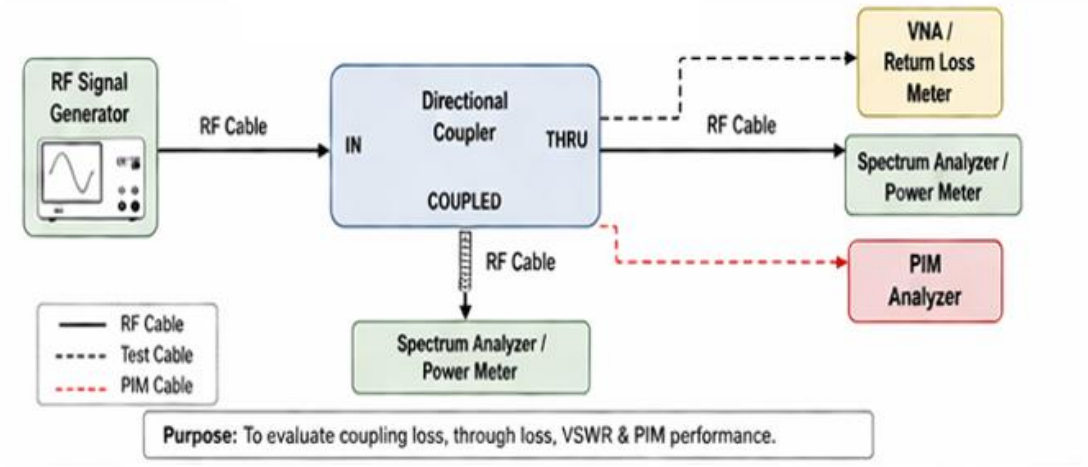
Test No.	Test Case – 2 (For clauses 2.2.1.1, 2.2.1.2 and 2.2.1.3)
Test Details	**Multiplexer (MUX)** The Multiplexer (MUX) in a Passive DAS is a passive RF band-management network element that combines or separates multiple frequency bands from one or more operators before distribution within the DAS. It enables efficient handling of different radio access technologies and frequency ranges while maintaining high isolation between bands to prevent interference and intermodulation. This includes diplexers, triplexers, and pentaplexers, which manage two, three, or five frequency bands, respectively. All such devices operate without external power and preserve RF signal integrity by introducing minimal insertion loss and distortion, ensuring reliable multi-band, multi-operator performance throughout the Passive DAS infrastructure.
Test Setup	**TEST SETUP 2: Multiplexer (MUX)** 

Test Procedure	1. Connect the RF Signal Generator to the input port(s) of the Multiplexer (Diplexer/Triplexer/Pentaplexer). 2. Connect the Spectrum Analyzer or Power Meter to the corresponding output port(s). 3. Generate RF signals at designated frequency bands applicable to each port of the multiplexer. 4. Measure insertion loss between input and respective output ports across the specified frequency bands. 5. Measure isolation between different ports by applying signal at one port and observing leakage at other ports. 6. Measure VSWR at each port using appropriate test setup (e.g., return loss measurement). 7. Verify Passive Intermodulation (PIM) performance using PIM analyzer under specified test conditions (e.g., 2×43 dBm). 8. Record all measured parameters and compare with specified limits.
Test Instruments Required	RF Signal Generator, Spectrum Analyzer, Vector Network Analyzer (VNA) / Return Loss Meter, PIM Analyzer, RF Cables, Connectors, Power Meter
Test Limits	As per the specified RF performance parameters defined for Passive DAS components in the applicable TEC Generic Requirements, including insertion loss, isolation, VSWR, PIM, and power handling. Where applicable, compliance shall also be aligned with relevant international standards such as IEC 62037 (Passive Intermodulation), IEC 61169 (RF connectors), and other equivalent industry standards.
Expected Results	The Multiplexer shall demonstrate compliance with specified electrical characteristics including insertion loss, isolation, VSWR, impedance, and PIM performance. The device shall effectively combine and separate frequency bands without significant signal degradation, interference, or

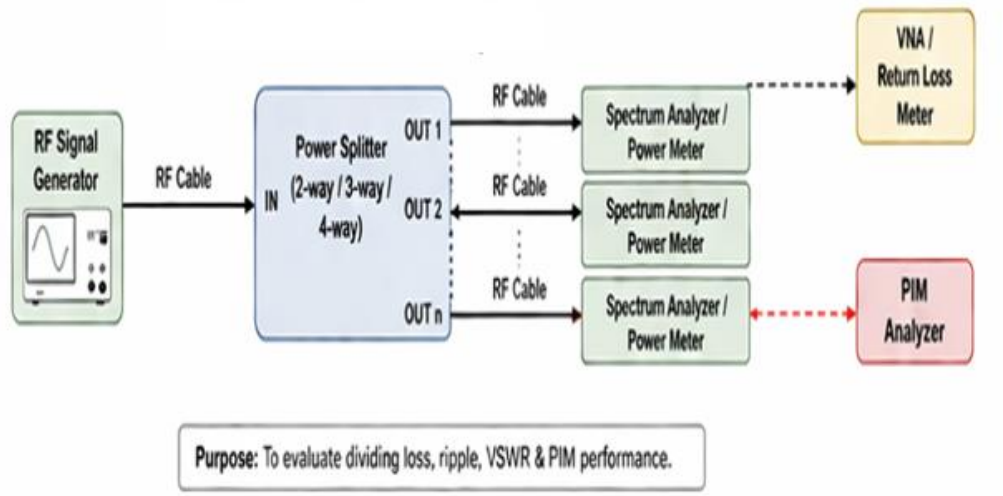
	intermodulation, ensuring reliable multi-band operation within the Passive DAS.

Test No.	Test Case – 3 (For clauses 2.2.2.1 and 2.2.2.2)
Test Details	**Combiner** The Combiner shall aggregate RF signals from multiple operators and/or frequency bands into a combined RF output for distribution over a common RF backbone. It shall support simultaneous multi-operator signal distribution while ensuring adequate isolation between input ports to minimize interference. The combiner shall maintain signal linearity and impedance characteristics across the supported operating frequency range and shall be suitable for continuous passive operation in indoor Passive DAS deployments.
Test Setup	**TEST SETUP 3: Combiner** 
Test Procedure	1. Connect RF Signal Generators to all input ports of the Combiner. 2. Configure each signal generator to operate at designated frequency bands within the supported range. 3. Measure the combined RF output at the output port(s) using a Spectrum Analyzer.

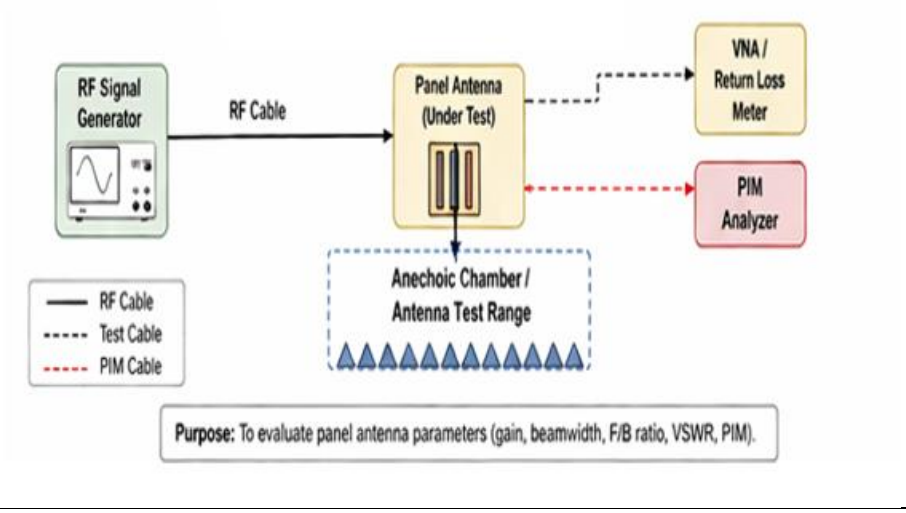
	4. Verify combining loss by comparing input and output power levels. 5. Measure isolation between input ports by injecting signal into one port and measuring leakage at other ports. 6. Measure VSWR at all ports using a Vector Network Analyzer (VNA). 7. Verify Passive Intermodulation (PIM) performance using a PIM Analyzer under specified test conditions (e.g., 2 × 43 dBm). 8. Confirm impedance matching and overall RF performance across the operating frequency band.
Test Instruments Required	RF Signal Generators, Spectrum Analyzer, Vector Network Analyzer (VNA), PIM Analyzer, RF Cables, Power Meter, Attenuators/Loads (as required)
Test Limits	As per the specified RF performance parameters defined for Passive DAS components in the applicable TEC Generic Requirements, including combining loss, isolation, VSWR, PIM, impedance, and power handling. Compliance shall also be aligned, where applicable, with relevant international standards such as IEC 62037 and IEC 61169.
Expected Results	The Combiner shall successfully aggregate multiple RF input signals with combining loss, isolation, VSWR, and PIM levels within specified limits. No abnormal distortion, mismatch, or excessive loss shall be observed, and the device shall demonstrate stable and compliant performance across the supported frequency range.

Test No.	Test Case – 4 (For clauses 2.2.3.1, 2.2.3.2 and 2.2.3.3)
Test Details	**Coupler** The Directional Coupler is a critical passive network element in a Passive Distributed Antenna System (PDAS), designed to extract a predefined portion of RF power from the main backbone cable while allowing the majority of the signal to continue uninterrupted along the primary transmission path. This functionality enables controlled distribution of signal power over extended cable runs to multiple remote antenna locations, ensuring balanced coverage across different areas within a building or facility. Directional couplers with standard coupling values such as 6 dB, 10 dB, and 15 dB are typically employed to achieve the required level of signal tapping based on coverage and design requirements.
Test Setup	**TEST SETUP 4: Directional Coupler** 

Test Procedure	1. Connect RF Signal Generator to the input port of the Directional Coupler. 2. Terminate all unused ports with matched 50-ohm loads. 3. Measure output power at the through port and coupled port using a Spectrum Analyzer or Power Meter. 4. Verify coupling loss by comparing input power with power measured at the coupled port. 5. Verify through loss by comparing input power with output power at the through port. 6. Measure VSWR at all ports using a Vector Network Analyzer (VNA). 7. Measure Passive Intermodulation (PIM) performance using a PIM Analyzer under specified conditions (e.g., 2×43 dBm). 8. Repeat measurements across the supported frequency range and for different coupling values (6 dB, 10 dB, 15 dB).
Test Instruments Required	RF Signal Generator, Spectrum Analyzer, Vector Network Analyzer (VNA), PIM Analyzer, RF Cables, Power Meter, Precision Loads/Terminators
Test Limits	As per the specified RF performance parameters defined for Passive DAS components in the applicable TEC Generic Requirements, including coupling loss, through loss, VSWR, PIM, impedance, and power handling. Compliance shall also be aligned, where applicable, with relevant international standards such as IEC 62037 and IEC 61169.
Expected Results	The Directional Coupler shall exhibit coupling loss and through loss within specified limits, with proper power division characteristics. VSWR and PIM levels shall remain within acceptable limits, and the device shall demonstrate stable and consistent performance across the supported frequency range without abnormal loss or signal degradation.

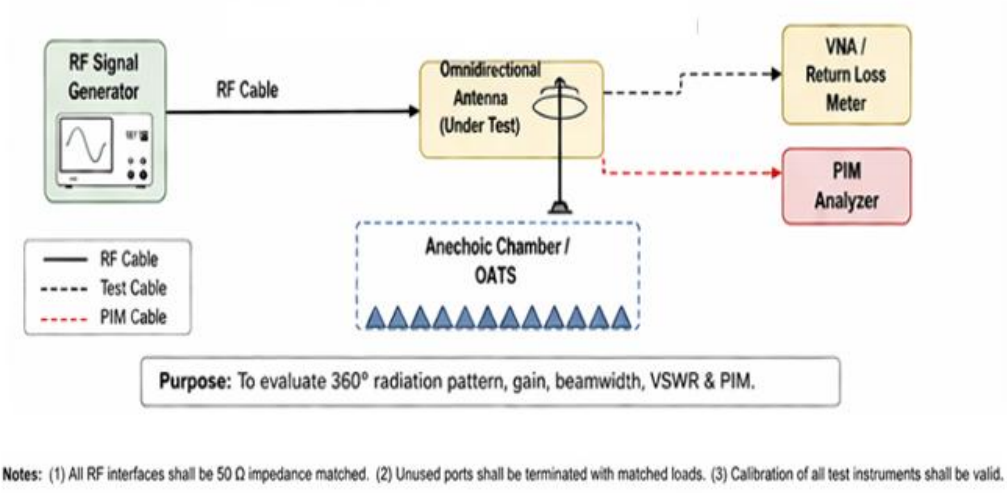
Test No.	Test Case – 5 (For clauses 2.2.4.1, 2.2.4.2 and 2.2.4)
Test Details	**Splitter** The Splitter is a passive RF network element in a Passive DAS used to divide an input RF signal into multiple output paths for distribution to downstream antennas or RF branches. It shall provide either equal or designed power division while preserving RF signal integrity and maintaining proper impedance matching at all ports to minimize losses and reflections within the DAS network. Any unused output ports shall be terminated with suitable RF loads to ensure stable system operation and to prevent degradation of overall Passive DAS performance
Test Setup	**TEST SETUP 5: Power Splitter** 
Test Procedure	1. Connect RF Signal Generator to the input port of the Power Splitter. 2. Terminate all output ports with matched 50-ohm loads. 3. Measure output power at each output port using a Spectrum Analyzer or Power Meter.

	4. Verify dividing loss by comparing input power with output power at each port. 5. Measure in-band ripple across the operating frequency range using a Vector Network Analyzer (VNA). 6. Measure VSWR at input and output ports using VNA. 7. Measure Passive Intermodulation (PIM) performance using a PIM Analyzer under specified conditions (e.g., 2×43 dBm). 8. Repeat measurements for all configurations (2-way, 3-way, 4-way) across the supported frequency range.
Test Instruments Required	RF Signal Generator, Spectrum Analyzer, Vector Network Analyzer (VNA), PIM Analyzer, RF Cables, Power Meter, Precision Loads/Terminators
Test Limits	As per the specified RF performance parameters defined for Passive DAS components in the applicable TEC Generic Requirements, including dividing loss, in-band ripple, VSWR, PIM, impedance, and power handling. Compliance shall also be aligned, where applicable, with relevant international standards such as IEC 62037 and IEC 61169.
Expected Results	The Power Splitter shall exhibit uniform and controlled power division across all output ports, with dividing loss, ripple, VSWR, and PIM levels within specified limits. The device shall maintain impedance matching and demonstrate stable performance across the supported frequency range without abnormal attenuation or signal distortion.

Test No.	Test Case – 6 (For clauses 2.2.5.1.1 and 2.2.5.1.2)
Test Details	**Panel Antenna** A Panel Antenna is a directional radiating element in a Passive DAS that provides controlled RF coverage within a defined sector. It is used in areas requiring focused radiation, such as corridors, tunnels, platform edges, and linear indoor environments, to optimize coverage and limit interference. Panel antennas support broadband operation across relevant cellular and wireless service bands and are configured in SISO (Single Input Single Output) or MIMO (Multiple Input Multiple Output) arrangements to enhance spectral efficiency, throughput, and link reliability for modern multi carrier systems. In MIMO configurations, multiple ports and polarization diversity improve channel capacity and resilience to multipath fading, which is essential for 4G LTE and 5G NR performance in dense indoor settings.
Test Setup	**TEST SETUP 6: Panel Antenna** 

Test Procedure	1. Connect RF Signal Generator to the input port of the Panel Antenna. 2. Place the antenna in an anechoic chamber or equivalent controlled test environment. 3. Measure antenna gain using standard antenna measurement techniques. 4. Measure horizontal and vertical beamwidth through radiation pattern analysis. 5. Verify front-to-back ratio using directional radiation measurements. 6. Measure VSWR across the supported frequency range using a Vector Network Analyzer (VNA). 7. Verify polarization characteristics (Vertical for SISO / ±45° for MIMO configurations). 8. Measure Passive Intermodulation (PIM) performance using a PIM Analyzer under specified conditions (e.g., 2×43 dBm). 9. Verify impedance matching and input power handling capability. 10. Repeat measurements for both SISO and 2×2 MIMO configurations, as applicable.
Test Instruments Required	RF Signal Generator, Spectrum Analyzer, Vector Network Analyzer (VNA), PIM Analyzer, Anechoic Chamber / Antenna Test Range, Power Meter, RF Cables
Test Limits	As per the specified RF performance parameters defined for Panel Antennas in the applicable TEC Generic Requirements, including gain, beamwidth, front-to-back ratio, VSWR, polarization, PIM, impedance, and power handling. Compliance shall also be aligned, where applicable, with relevant international standards such as IEC 62037 (Passive Intermodulation Measurement), IEC 61169 series (RF Connectors), ETSI EN 302 326 (Fixed Radio Systems Antennas), IEC 62153 series (Metallic Communication Cable Test Methods, where applicable), and other equivalent industry standards.

Expected Results	The Panel Antenna shall exhibit directional radiation characteristics with gain, beamwidth, front-to-back ratio, VSWR, and PIM levels within specified limits. The antenna shall maintain stable and efficient RF radiation performance across the supported frequency range, without abnormal distortion, mismatch, or degradation.

Test No.	Test Case – 7 (For clauses 2.2.5.2, 2.2.5.2.1, 2.2.5.2.2 and 2.2.5.2.3)
Test Details	**Omnidirectional Antenna** The Omnidirectional Antenna provides uniform RF radiation in the horizontal plane, suitable for large, open indoor areas such as halls, lobbies, and open spaces where broad coverage is needed. Ensures even RF distribution in all horizontal directions from a central location for consistent signal strength. Omnidirectional antennas in Passive DAS also support broadband frequency ranges and can be built for SISO or MIMO configurations, enabling simultaneous support for multiple signal paths and improving overall system capacity and performance. MIMO omnidirectional antennas particularly benefit capacity and spectral efficiency in environments with high user density.
Test Setup	**TEST SETUP 7: Omnidirectional Antenna**  Notes: (1) All RF interfaces shall be 50 Ω impedance matched. (2) Unused ports shall be terminated with matched loads. (3) Calibration of all test instruments shall be valid.
Test Procedure	1. Place the Omnidirectional Antenna in a calibrated antenna measurement environment such as an anechoic chamber or open area test site (OATS). 2. Connect the RF Signal Generator to the antenna input port using

	appropriate RF cables. 3. Configure the signal generator to operate over the supported frequency bands of the antenna. 4. Measure VSWR across the operating frequency range using a Vector Network Analyzer (VNA). 5. Measure antenna gain and radiation characteristics using a standard antenna measurement setup. 6. Perform full azimuth (0° to 360°) radiation pattern measurement to verify uniform horizontal coverage. 7. Measure vertical beamwidth and verify compliance with specified limits. 8. Conduct Passive Intermodulation (PIM) test using PIM Analyzer at specified input power levels (2×43 dBm). 9. Verify impedance matching and return loss characteristics. 10. Record all measured parameters and compare with specified technical requirements.
Test Instruments Required	RF Signal Generator, Vector Network Analyzer (VNA), Spectrum Analyzer, PIM Analyzer, Antenna Measurement System (Anechoic Chamber/OATS), RF Cables, Power Meter
Test Limits	As per the specified RF performance parameters defined for Omnidirectional Antennas in Passive DAS under the applicable TEC Generic Requirements, including gain, beamwidth, VSWR, impedance, PIM, and power handling. Where applicable, compliance shall also be aligned with relevant international standards such as IEC 62037 (Passive Intermodulation), IEC 61169 (RF connectors), and other equivalent industry standards.
Expected Results	The Omnidirectional Antenna shall exhibit uniform radiation characteristics across 360° in the horizontal plane, with all measured RF parameters conforming to the specified limits. The antenna shall operate without abnormal variation, distortion, or performance degradation and shall ensure consistent signal coverage suitable for indoor Passive DAS deployments.

J. Summary of test results

GR/IR No._____

TSTP No._____

Equipment name & Model No._____

Clause No.	**Compliance** *(Complied /Not Complied / Submitted/Not Submitted / Not Applicable)*	***Remarks / Test Report Annexure No.***

[Add as per requirement]

Date:

Place: ***Signature & Name of TEC testing Officer / * Signature of Applicant / Authorized Signatory***

**** Section J as given above is also to be submitted by the Applicant/ Authorised signatory as part of in-house test results along with Form-A. The Authorised signatory shall be the same as the one for Form 'A'.***