

SECTION 27 53 19

DISTRIBUTED ANTENNA SYSTEM (DAS)

PART 1 - GENERAL

1.01 SECTION INCLUDES

This specification describes technical and performance criteria for deploying a Neutral-Host Distributed Antenna System (DAS) capable of supporting Wireless Service Providers (WSP) and Public Safety Networks (PSN). The DAS components specified in this document include: Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners, Couplers, Fiber-Optic Cable, Fiber-Optic Connectors, and Fiber-Optic Jumpers, Bi-Directional Amplifiers (BDA), Fiber-Optic Master Unit and Fiber-Optic Remote Units.

1.02 SYSTEM DESCRIPTION

- A. Services: Upon commissioning, the DAS shall provide coverage for the WSPs listed below on all frequencies currently being used by the designated WSPs
 - 1. AT&T Wireless
 - 2. Sprint/Nextel
 - 3. T-Mobile
 - 4. Verizon
 - 5. Public Safety – According local requirements. Example: 800 MHz PSN coverage, city of Grapevine, TX Ordinance No. 109.2
- B. The system shall be able to transport and integrate in the DAS solution the PSN frequencies according the local requirements and ordinances.
- C. Expansion: Without replacing the Passive DAS Infrastructure, the DAS shall have expansion capabilities to support the following WSP and PSN frequencies deployed in a SISO antenna environment. Any additional Components required for system expansion shall comply with all specifications of this Section.
 Notify and provide in your response the operators requirements in the market for MIMO.

<u>Service</u>	<u>Uplink, MHz</u>	<u>Downlink, MHz</u>
Cellular	824 - 849	869 - 894
PCS	1850 - 1915	1930 - 1995
AWS	1710 - 1755	2110 - 2155
Commercial 700 Band	698 - 716,776-787	728 - 746
Narrow Band Public Safety 700 Band	799 - 805	769 - 775
800 Band	806 - 824	851 - 869
900 Band	896 - 902	935 - 941
BRS/EBS	2496-2690	

- D. WSP Approval: the Contractor shall propose and deploy a DAS system with equipment that is WSP approved and a RF design and installation that

guarantees WSP approval for interconnection to the WSPs' macro networks or BTS equipment. The system will not be turned on without previous WSP acceptance and retransmission agreement. Contractor is responsible to obtain WSP approval. Contractor is responsible to ensure the RF design adapts to the carrier requirements in all stages of the project.

- E. Costs associated with each respective RF Source Type and potential costs needs to be included in the response document
- F. Situations where the WSP must own the BDA/Repeater needs to be clearly identified and included in the response document
- G. The Contractor working with the end user customer is responsible for confirming that the site has the necessary space and power to support the DAS as well as the RF Sources including either BDA/Repeaters and indentify the potential power required for Cellular Base Stations.
- H. PSN Approval: The Contractor shall propose and deploy a DAS system capable of receiving approval of the PSN Authority Having Jurisdiction (AHJ).
- I. Broadband Active Distribution: Single-mode fiber-optic cable will be used for Active distribution. In-line amplifiers are not allowed.
- J. Network Management:
 - 1. NMS: The DAS shall have a Network Management System (NMS) capable of alarm, monitor, configuration and control of all Active Components.
 - 2. SNMP Integration: The DAS NMS shall be capable of integration with 3rd party SNMP based NMS products for alarm purposes and provide alarming information.

1.03 ALTERNATIVES

- A. No alternative component(s) shall be accepted as equal to the components and manufacturers specified in this document unless the Contractor proves that the alternative component(s) are of equal or superior specifications and quality, and that they have been used in similar projects of size and complexity for no less than 3-years. The following information shall be required for each alternative component with submittal of the bid response:
 - 1. Passive Components:
 - a. Product samples
 - b. Detailed product specifications
 - c. Independent test results verifying the product specifications
 - d. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall remain available for new purchase for a period of 7-years from the date of system acceptance.
 - 2. Active Components:
 - a. Hardware and software manuals
 - b. Detailed product specifications
 - c. Mean Time Between Failure (MTBF) data for each Active Component
 - d. Independent test results verifying the product specifications
 - e. Written documentation from the manufacturer guaranteeing that the alternative component(s) shall be supported for a period of 7-years from the date of system acceptance.
 - f. For Active Components serving the WSPs, written documentation from the WSPs that the alternative component(s) are approved for use within the WSP's network and that interconnection of the DAS to

the WSP's network will not be withheld due to the alternative component being used in the DAS.

- g. For Active Components serving the PSN, written documentation from the AHJ that the alternative component(s) are approved for use within the PSN and that system acceptance of the DAS to the PSN will not be withheld due to the alternative component being used in the DAS.

1.04 CODES, STANDARDS AND CERTIFICATIONS

- A. All work, including but not limited to: cabling, pathways, support structures, wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractor's Association (NECA) Standard of Installation. In case of discrepancy or disagreement between the documents noted above, the contractor shall satisfy the most stringent requirements.
- B. Requirements set forth by first-responder code, ordinance, or the PSN AHJ shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN AHJ.

1.05 ABBREVIATIONS AND ACRONYMS

- A. ACG: Automatic Gain Control
- B. AHJ: Authority Having Jurisdiction
- C. ATP: Acceptance Test Plan
- D. AWS: Advanced Wireless Service
- E. BDA: Bi-Direction Amplifier
- F. BOM: Bill-of-Material
- G. BRS: Broadband Radio Service
- H. BTS: Base Transceiver Station
- I. CDMA: Code Division Multiple Access
- J. C/N: Carrier-to-Noise Ratio
- K. CWDM: Coarse Wave Division Multiplexing
- L. DAS: Distributed Antenna System
- M. DWDM: Dense Wave Division Multiplexing
- N. EBS: Educational Broadband Service
- O. ESMR: Enhanced Specialized Mobile Radio
- P. FCC: Federal Communications Commission
- Q. GUI: Graphical User Interface
- R. iDEN: Integrated Enhanced Digital Network
- S. LMR: Land Mobile Radio
- T. LTE: Long Term Evolution
- U. MTBF: Mean Time Between Failure
- V. NFPA: National Fire Protection Association
- W. NMS: Network Management System

- X. PCS: Personal Communications System
- Y. PSN: Public Safety Network
- Z. RoF: Radio-over-Fiber
- AA. PIM Passive Intermodulation
- BB. MIMO Multiple-Input, Multiple-Output
- CC. LTE Long Term Evolution
- DD. RoHS: Restriction of Hazardous Substances
- EE. RSL: Received Signal Level
- FF. SISO: Single-Input, Single-Output
- GG. SMR: Specialized Mobile Radio
- HH. SMS: Short Message Service
- II. SNIR: Signal-to-Noise Interference Ratio
- JJ. SNMP: Simple Network Management Protocol
- KK. SOW: Statement of Work
- LL. VSWR: Voltage Standing Wave Ratio
- MM. WSP: Wireless Service Provider

1.06 DEFINITIONS

- A. Acceptance: Expressed approval by the customer
- B. Active: DAS components that require AC/DC power for operation
- C. Carrier Approval: Expressed written approval to interconnect to the WSP macro network
- D. Channel: A path for an RF transmission between two points
- E. Component: A main system element of the DAS
- F. Contractor: The prime contractor bidding the project
- G. Passive: DAS components that do not require AC/DC power for operation

1.07 PERFORMANCE REQUIREMENTS

- A. WSP DAS:
 - 1. On a per channel basis, the downlink RSL for each frequency band shall meet or exceed the criteria in Table 1

Table 1. System Parameters

Parameters	Unit	Lower 700 MHz, BRS/EBS	Cellular, PCS, AWS, Commercial 800/900 MHz	Public Safety 380 - 512, 700, 800 MHz
Minimum downlink receive signal level (RSL)	dBm	-77	-85	-95

Contractor in their response shall identify the specific market criteria requested by each respective WSP. Those have to be highlighted and the impact in the project quantified separately from the basic requirements requested in table 1.

Ultimately it is the Contractor's responsibility to confirm that all design requirements for each respective WSP are met with their proposed solution. For example, in certain markets the WSP has a specific requirement for RSSI of -65 dBm at the windows.

2. Contractor shall state the assumed channel loading and frequency bands for the proposed WSP in-building coverage. Prior to installation, contractors shall confirm the channel loading and frequency use in the serving area, and shall guarantee coverage for these channels per the criteria in Table 1.
3. The DAS shall deliver coverage per the criteria in Table 1 throughout 95% of the building. Unless stated separately in the floor plans it is expected coverage including stairwells, elevators, basement and garage. Total Number of Floors: (BLANK) Square Footage: Per Floor: (BLANK) Square Footage Total: (BLANK).
4. The contractor shall explain the method used to avoid downlink and uplink interference.

B. PSN DAS:

1. The PSN DAS shall comply with NFPA-1 2012 Edition
2. Where the in-building coverage requirements include 700 - 800 MHz public safety system and commercial wireless in-building coverage, the two systems shall be able to operate over a unified Passive Cable and Coverage Antenna Infrastructure.
3. Contractors shall state the assumed channel count for the PSN Frequency Bands identified above in Section 1.02 A. with submittal of bid response. Prior to installation, contractors shall confirm the channel count and frequencies with the AHJ, and shall guarantee coverage for these channels per the criteria stated above.
4. The DAS shall be capable of upgrade, without additional hardware or software, to allow for changes to system frequencies within the deployed frequency band in order to maintain radio system coverage as originally designed.
5. The contractor shall explain the method used to avoid downlink and uplink interference.

1.08 ADDITIONAL REQUIREMENTS

- A. PSN Approval: When approval of the DAS deployment is required by code or ordinance, the Contractor shall be responsible for facilitating the AHJ approval(s) per the requirements of the code or ordinance.

1.09 SUBMITTALS

A. Submittal Requirements with Bid Response:

1. Product Data: Submit manufacturer datasheets for the following components:
 - a. Donor and Coverage Antennas
 - b. Coaxial Cable and Connectors
 - c. Splitters, Combiners and Couplers
 - d. Bi-Directional Amplifiers (BDA)
 - e. Fiber-Optic Master Unit
 - f. Fiber-Optic Remote Units

2. Shop Drawings: Submit the following items:
 - a. RF link budget
 - b. Overlay of system Components on floor plans
 - c. Drawings for Donor Antenna and grounding
 - d. Bill-of-Material (BOM)
3. Statement of Work (SOW): Submit sample SOW
4. Acceptance Test Plan (ATP): Submit sample ATP
5. Recommended Spares
6. Warranty Documents:
 - a. Submit for all manufactured Components specified in this Section.
 - b. Submit Contractor's System Warranty.
 - c. Submit Manufacturer's Extended Warranty.
- B. Submittal Requirements Prior to Start of Construction
 1. Final RF link budget
 2. Overlay of system Components on floor plans
 3. Drawings for Donor Antenna and grounding
 4. RF propagation modeling
 5. Signal to Noise Interference Ratio (SNIR) Map
 6. Bill-of-Material (BOM)
 7. Maintenance Service Contract
 8. Statement of Work (SOW): The contractor shall submit a SOW that has been accepted by the customer or customer's designated representative.
 9. Acceptance Test Plan (ATP): The contractor shall submit an ATP that has been accepted by the customer or customer's designated representative.
- C. Submittal Requirements at Close Out
 1. Drawings: Submit as-built drawings indicating:
 - a. Donor antenna, grounding and lighting protection details
 - b. Cable routing, splitters, couplers and coverage antenna locations
 - c. Active component locations, layout and configuration
 2. Test Reports
 - a. WSP DAS: Submit accepted ATP reports confirming the requirements of Section 1.07 A have been met.
 - b. PSN: Submit Accepted ATP reports confirming the requirements of Section 1.07 B have been met.
 3. Field Reports: Submit sweep-testing results for all cable runs.
 4. Field Reports: Submit OTDR test results for all fiber runs.
 5. Operation and Maintenance Data: Submit hardware and software manuals for all Active Components.
 6. Warranty Documents:
 - a. Submit for all manufactured components specified in this Section.
 - b. Submit Contractor's System Warranty.
 - c. Submit Manufacturer's Extended Warranty

1.10 QUALITY ASSURANCE

- A. Qualifications: Contractor, and/or Sub-Contractors, shall have a minimum of 5-years full-time experience executing work of similar scope and complexity.
- B. Certifications:

- a. Passive Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.
- b. Active Components: Contractor or Sub-Contractor shall provide manufacturer certification that their personnel have been trained on the components being installed.

1.11 WARRANTY

- A. Manufacturer Warranty:
 - 1. Splitters, Couplers and Coverage Antennas: 5-year limited warranty from date of system acceptance.
 - 2. Coaxial Cable and Connectors: 10-year limited warranty from date of system acceptance.
 - 3. Fiber-Optic Cable: 20-year limited warranty from date of system acceptance.
 - 4. Active Components: The earliest of 1-year limited warranty from date of system installation or 15 months from date of shipment.
- B. Contractor Warranty: Contractor shall warrant the system performance as specified in Section 1.07 for 1-year.

1.12 MAINTENANCE

The Contractor shall provide an optional maintenance service contract, covering for a period of one-year: preventative maintenance, system monitoring, spares, fault mitigation, equipment repair, and response time.

1.13 CONTRACTOR CREDENTIALS

The Contractor shall document their relations with the equipment manufacturer, certifications with the manufacturer and significant success stories.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- 1. Specified Manufacturer: CommScope/Andrew
- 2. Acceptable Manufacturers: As permitted in Section 1.03.

2.02 COMPONENTS

- A. Broadband Donor Antennas: Broadband Donor Antennas shall feature a multi-band design, accommodating Cellular, PCS, LMR and AWS frequencies in a single small antenna.
 - 1. Electrical:
 - a. Frequency bands, 806 - 960 MHz and 1710 - 2200 MHz
 - b. VSWR \leq 1.8
 - c. Gain: 806-960 \geq 10.5 dBi, 1710 - 2200 \geq 12 dBi
 - d. Maximum input power: 100 watts
 - e. Polarization: Vertical
 - f. Front-to-back ratio: 806 - 960 \geq 18 dB, 1710 - 2200 \geq 20 dB
 - g. Impedance: 50 Ω
 - h. Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this Section.
 - 2. Mechanical:
 - a. Radome material: UV-protected ABS
 - b. Pigtail cable: RG58, plenum rated

- c. Connector: 50 Ω N Type Female
 - d. Mounting: Pole
3. Environmental
 - a. Temperature: -40 °C to +60 °C
 - b. Lighting protection: Direct ground
 - c. Waterproof level: IP 66
 - d. Wind Speed, maximum: 125 mph
 4. Approved Manufacturer: Andrew CELLMAX-EXT-CPU or equivalent, in accordance with Section 1.03.
- B. 700 MHz LMR Yagi Donor Antennas:
1. Electrical:
 - a. Frequency band, 746 - 806 MHz
 - b. VSWR \leq 1.5:1
 - c. Gain: \geq 1 1.1 dBi
 - d. Maximum input power: 100 watts
 - e. Polarization: Vertical
 - f. Front-to-back ratio: \geq 15 dB
 - g. Impedance: 50 Ω
 - h. Beamwidth, Horizontal, degrees: 60
 - i. Azimuth Pattern: As proposed by the manufacturer to meet the performance specifications in this Section.
 2. Mechanical:
 - a. Connector: 50 Ω N Type Female
 - b. Mounting: Pole
 3. Environmental:
 - a. Temperature: -40 °C to +60 °C
 - b. Lighting protection: Direct ground
 - c. Waterproof level: IP 66
 - d. Wind Speed, maximum: 125 mph
 4. Approved Manufacturer: Andrew DB498-PS or equivalent in accordance with Section 1.03.
- C. Omni-Directional Coverage: Omni-Directional Coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
1. Electrical Band 1:
 - a. Frequency Band: 698 - 800 MHz
 - b. VSWR: \leq 1.8:1
 - c. Gain: \geq 1.5 dBi
 - d. Maximum input power:
 - e. Impedance: 50 Ω
 - f. Beamwidth, Horizontal: 360° omnidirectional
 - g. Beamwidth, Vertical: 80° nominal
 - h. Return Loss: 10.9 dB
 2. Electrical Band 2:
 - a. Frequency Band: 1710 - 2700 MHz and 800 - 960 MHz
 - b. VSWR: \leq 1.5:1
 - c. Gain: \geq 1.5 dBi @ 800-960 MHz and \geq 5.0 dBi @ 1710 - 2700 MHz
 - d. Maximum input power:
 - e. Impedance: 50 Ω

- f. Beamwidth, Horizontal: 360° omnidirectional
 - g. Beamwidth, Vertical: 65° nominal
 - h. Return Loss: ≤ 13.9 dB
3. Mechanical:
 - a. Connector: 50 Ω N Type Female
 - b. Mounting: Thru-hole ceiling mount
 - c. Radome material: ABS, UV resistant
 - d. Pigtail cable: KSR195, plenum rated
 4. Environmental:
 - a. Application: Indoor
 - b. Operating Temperature: 40 °C to +60 °C (40 °F to +140 °F)
 - c. Relative Humidity: Up to 100%
 5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
 6. Approved Manufacturer: Andrew CELLMAX-O-CPUSE or equivalent, in accordance with Section 1.03.
- D. Directional Coverage Antennas: Directional coverage antennas shall feature a multi-band design, accommodating multiple frequency bands in a single small antenna.
1. Electrical Band 1:
 - a. Frequency Band: 698 – 800 MHz
 - b. VSWR: ≤ 1.8:1
 - c. Gain: ≥ 5.0 dBi @ 698 – 800 MHz
 - d. Maximum input power: 50W
 - e. Impedance: 50 Ω
 - f. Beamwidth, Horizontal: 110° nominal
 - g. Polarization: Vertical
 - h. Return Loss: ≤ 10.9 dB
 2. Electrical Band 2:
 - a. Frequency Band: 1710 – 2700 MHz and 800 – 960 MHz
 - b. VSWR: ≤ 1.5:1
 - c. Gain: ≥ 5.0 dBi @ 800 – 960 MHz and ≥ 6.0 dBi @ 2170 – 2700 MHz and ≥ 8.0 dBi @ 1710 – 2170 MHz
 - d. Maximum input power:
 - e. Impedance: 50 Ω
 - f. Beamwidth, Horizontal: 90° nominal
 - g. Return Loss: ≤ 13.9 dB
 3. Mechanical:
 - a. Connector: 50 Ω N Type Female
 - b. Mounting: 4-hole wall mounting plate
 - c. Radome material: ABS, UV resistant
 - d. Pigtail cable: RG58, plenum rated
 4. Environmental:
 - a. Application: Indoor
 - b. Operating Temperature: 40 °C to +60 °C (40 °F to +140 °F)
 - c. Relative Humidity: Up to 100%
 5. Regulatory Compliance/Certifications: RoHS 2002/95/EC
 6. Approved Manufacturer: Andrew CELLMAX-D-CPUSE or equivalent, in accordance with Section 1.03
- E. Fiber-Optic Cable and Connectors:

1. General Specifications:
 - a. Cables shall be six-strand or greater, designed for point-to-point applications as well as mid-span access, and shall provide a high-level of protection for optical fiber installed in interior building environments.
 - b. Higher optical fiber count cables shall utilize a sub-unitized design with color-coded subunits for easy identification.
 - c. Single-mode optical fibers shall be 8.3 μm and use standard colored tight-buffered construction.
 - d. The single-mode optical fiber shall be dispersion-unshifted optical fiber that meets ITU-T G.652c standards.
 - e. Cable shall provide optimum performance over entire wavelength range from 1260 to 1625 nanometers.
 - f. Cable shall support new and emerging applications that utilize extended E band, 1360 to 1460 nanometers.
 - g. Cable shall also support existing and legacy single-mode applications that traditionally operate in 1310 and 1550 nanometer regions.
 - h. Cable shall deliver a cost-effective upgrade path by expanding available wavelengths by 50 percent supporting 16 Channels of coarse wave division multiplexing (CWDM) on a single optical fiber and up to 400 Channels of dense wave division multiplexing (DWDM) on a single cable.
 - i. Fire ratings: Riser, plenum, and/or LSZH
 - j. Approved Manufacture: CommScope Fiber Optic Cable containing TerraSpeed Single Mode Optical Fiber. As an example, P-006-BO-8W-F25YL, 6-strand breakout cable single-mode Fiber or equal in accordance with Section 1.03.

- F. Fiber-Optic Pigtails:
 1. General Specifications:
 - a. To maintain channel integrity, optical fiber patch cords and pigtails shall be fabricated to meet the performance parameters corresponding to the optical fiber cable approved product type specified below. Patch cord and pigtail plug connectors shall be equipped with boots, and shall have same colors as related optical fiber backbone cables, unless specified or indicated otherwise. Optical fiber patch cords and pigtails shall be available with the following options as specified or indicated:
 - 1) Termination types: SC-APC
 - 2) Connector/cable configuration: Simplex and duplex
 - 3) Fire ratings: Riser, plenum and/or LSZH
 - 4) Patch cord outside diameters: 1.6 millimeters (0.063 inches) and 3.0 millimeters (0.118 inches)
 - 5) Pigtails: Ruggedized and tight-buffered optical fiber – 0.9 millimeters (0.035 inches) outside diameter
 - 6) Lengths: As specified or indicated
 - 7) Approved Manufacturer: CommScope RFT-01RF09-8W-SCA-XX, single reinforced buffered 900 μm , LightScope ZWP single-mode fiber, angled polished connector or equivalent, in accordance with Section 1.03.

- G. Air Dielectric, Plenum Rated Cable:
 1. Material Characteristics:

- a. Jacket: Halogenated, Fire-Retardant
 - b. Outer Conductor Material: Corrugated Aluminum or Corrugated Copper
 - c. Inner Conductor Material: Copper-Clad Aluminum Wire
2. Electrical Characteristics:
- a. Impedance: $50 \pm 2.0 \Omega$
 - b. Frequency Band: 1 - 8800 MHz
 - c. Peak Power Rating: $\geq 40.0 \text{ kW}$
3. Mechanical Characteristics:
- a. Diameter Over Jacket: $\leq .627 \text{ in}$
 - b. Minimum Bending Radius: $\leq 5 \text{ in}$
 - c. One Time Minimum Bending Radius: $\leq 3 \text{ in}$
4. Attenuation Characteristics shall meet Table2:

Table 2: Attenuation characteristics of Air Dielectric Plenum Rated cable

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.848
450	≤ 1.53
800	≤ 2.105
2000	≤ 3.564

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Approved Manufacturer: Andrew HL4RP-50A, AL4RPV-50A or equivalent, in accordance with Section 1.03.

H. Foam Dielectric Cable:

1. Material Characteristics:
- a. Jacket: Non-halogenated, Fire-Retardant Ployolefin
 - b. Outer Conductor Material: Corrugated Copper
 - c. Inner Conductor Material: Copper-Clad Aluminum Wire or Copper Tube
2. Electrical Characteristics:
- a. Impedance: $50 \pm 1.0 \Omega$
 - b. Frequency Band: 1/2" Nominal: 1 - 8800 MHz, 7/8" Nominal: 1 - 5000 MHz
 - c. Peak Power Rating: $\geq 40.0 \text{ kW}$
3. Mechanical Characteristics:
- a. Diameter Over Jacket: 1/2" Nominal: $\leq .630 \text{ in}$, 7/8" Nominal: $\leq 1.1 \text{ in}$
 - b. Minimum Bending Radius: 1/2" Nominal: $\leq 5 \text{ in}$, 7/8" Nominal: $\leq 10 \text{ in}$
 - c. One Time Minimum Bending Radius: 1/2" Nominal: $\leq 2 \text{ in}$, 7/8" Nominal: $\leq 5 \text{ in}$
4. Attenuation Characteristics: 1/2" Nominal

Table 3: attenuation characteristics, 1/2" Foam Dielectric cable

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.815
450	≤ 1.447
800	≤ 1.968

2000	≤ 3.251
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Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

5. Attenuation Characteristics: 7/8" Nominal:

Table 4: attenuation characteristics 7/8" Foam Dielectric Cable

Frequency (MHz)	Attenuation (dB/100ft)
150	≤ 0.417
450	≤ .744
800	≤ 1.014
2000	≤ 1.683

Standard Conditions: VSWR 1.0, ambient temperature 20 °C (68 °F)

6. Approved Manufacturer: Andrew LDF4-50A, FXL-540-NHR, FXL-780-NHR or equivalent, in accordance with Section 1.03.

I. Splitters, Combiners, Couplers, Coax Jumpers and Connectors:

1. Approved Manufacturer: Andrew or equivalent, in accordance with Section 1.03.

J. BDA: When the AHJ and/or WSP dictates a BDA drive the DAS, the BDA shall be of modular design and use digital filtering to mitigate interference and accommodate multiple services for PSNs and WSPs.

1. Characteristics

- a. Operating Temperature Range: -33 °C to +50 °C
- b. Chassis: Shall be of modular design with ≥ 4 frequency bands per 19" chassis. Chassis shall not exceed four Rack Units (RUs) in height.
- c. Filtering: Digital with a minimum 10kHz step size
- d. Separate Control: Each RF amplifier shall be capable of adjusting and controlling power levels for each WSP when multiple WSPs share a single amplifier.
- e. FCC Part 90.219 Type Classification: Class A narrowband for LMR/SMR/ESMR frequency bands
- f. Alarming: Shall support both SNMP and SMS using wireless modem
- g. Mounting Options: shall support rack, wall and pole mounting
- h. Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS

2. Compliance:

- a. NFPA: The BDA shall comply with NFPA-1 2012 edition Annex O In-Building Public Safety Radio Enhancement Systems.
- b. FCC: Shall be FCC type certified.

3. Approved Manufacturer: Andrew Node A or equivalent, in accordance with Section 1.03.

K. Fiber-Optic Master Unit: When building size dictates an Active fiber DAS, the Fiber-Optic Master Unit shall convert radio over coax to Radio-Over-Fiber (RoF) for distribution to Fiber-Optic Remote Units.

1. Characteristics
 - a. Transmission Media: Single-mode fiber at 1310 nm
 - b. Operating Temperature Range: +5 °C to +40 °C
 - c. Impedence: 50 Ω
 - d. Chassis:
 - 1) Shall be of modular design capable of supporting ≥ 32 Remote Units per 19", 4 RU chassis
 - 2) Shall support redundant power supplies
 - 3) Shall have the capability to remotely power the Remote Units via composite fiber-optic cable
 - e. Point of interface units allowing for separate Uplink and Downlink attenuation.
 - f. Automatic Gain Control (AGC): Shall provide AGC for optical loss compensation
 - g. Optical Budget: Shall support ≤ 3 dB optical budget (~3 km or 2 miles)
 - h. Auxiliary Channel: Shall provide an input to support 400 to 2700 MHz for future expandability
 - i. Interlink: Shall support one fiber or two fibers bi-directional optical link for distances up to 20 km with a 10 dB optical budget
 - j. Remote Supervision:
 - 1) Shall support the TCP/IP protocol, SNMPv2, FTP, HTTP, Telnet, and be fully compatible with general purpose SNMP managers
 - 2) Remote access shall be available via Point-to-Point Protocol (PPP), over circuit-switched/packet data and wired/wireless modems
 - 3) Each Active device shall be manageable via a Web GUI
 - 4) Auto Mapping: Each board position shall be automatically mapped during system turn-up
2. Frequency Bands Supported: 380 - 512 MHz LMR, 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1900 - 1950 MHz PCS and 2496 - 2690 MHz BRS/EBS.
3. Approved Manufacturer: Andrew ION-B, ION-M or equivalent, in accordance with Section 1.03.

L. Fiber-Optic Remote Units: The Fiber-Optic Remote Unit converts the RoF signal back to radio over coax, as well as provides filtering so that multiple frequency bands can reside over the same passive cable and antenna infrastructure.

1. Characteristics
 - a. Operating Temperature Range: +5 °C to +40 °C
 - b. Impedence: 50 Ω
 - c. Power Consumption: ≤ 105 watts, maximum
 - d. Output Power per Carrier at Antenna Port:

Table 5: Frequencies/Technologies/Output Power, Optical Remote Unit

Technology/Band (MHz)	Single carrier (dBm)
Analog 700	27
GSM 700	27

Analog 800 and 850	27
GSM 850 and 850	31
GSM 850 and 850 at band edges	29
iDEN 800 and 850	26
iDEN 800 and 850 at band edges	24
CDMA 800 and 850	29
CDMA 800 and 850 at band edges	27
Analog 900	29
iDEN 900	23
CDMA 1700	30
W-CDMA 1700	28
Analog 1900	31
GSM 1900	31
CDMA 1900	29
W-CDMA 1900	27

- e. MTBF (excluding external power supply): $\geq 160,000$ hours
 - f. Physical: The Remote Unit shall consist of the following:
 - 1) Ingress Protection: IP31 or equivalent
 - 2) Frequency Bands supported: 769 - 806 MHz LMR, 806 - 869 MHz LMR/SMR/ESMR, 896 - 941MHz LMR/SMR/ESMR, 824 - 894 MHz Cellular, 1710 - 1755 MHz AWS, 1850 - 1995 MHz PCS
 - 3) Optical Port: 2xSC-APC connector (separated uplink/downlink)
 - 4) Antenna Port: Single 50 Ω N type female connector
 - 5) Auxiliary Ports: Two SMA female for future add-on modules
 - g. Uplink Noise Figure:
 - 1) LMR 700, LMR 800, Cell850: ≤ 7.5 dB
 - 2) LMR 700, LMR 800, Cell850 at band edges: ≤ 9.5 dB
 - 3) LMR 900: ≤ 8.5 dB
 - 4) AWS: ≤ 7.5 dB
 - 5) PCS 1900 extended: ≤ 7.5 dB
2. Approved Manufacturer: Andrew ION-B, ION-M Series or equivalent in accordance with Section 1.03.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. The contractor shall design, install, commission and test the DAS in accordance with the manufacturer's instructions and recommendations.
- B. The contractor shall install the DAS in accordance with the accepted SOW.

3.02 ACCEPTANCE TESTING

- A. Acceptance testing will be performed confirming the requirements of Section 1.07 have been met.

- B. The contractor shall complete the acceptance testing as prescribed in the approved Acceptance Test Plan (ATP) submittal.

END OF SECTION