TRACER WIRELESS APPLICATION GUIDE
7/15/14

www.adtran.com/tracer

Thank you for your interest in ADTRAN TRACER Wireless Products. We are very excited that you are considering TRACER to support your application requirements and are here to assist in every way we can to ensure that your experience with ADTRAN TRACER exceeds your expectations. This Application Guide will assist you with understanding the TRACER products, ancillary items, path engineering considerations and process, and the support services we offer from ADTRAN.

There are many applications and markets where the TRACER products can be used. We support applications that range from simple “Short Campus Building to Building Paths” up to “Long Cellular Backhaul Paths”. We also support “Intermediate Hop Paths” to provide a solution for hopping over / around obstructions or just extending the distance of the path. This Guide will cover each of these in more detail.

Step 1. Identify if ADTRAN has a product offering to support your requirements

Before we get started, there is an important thing to know. ADTRAN not only makes the TRACER Wireless products, but also has a full complement of Enterprise and Carrier products to support most voice, data, and video applications.

Here are some quick examples of common application requirements and suggested TRACER product solutions. Of course, there are many variables involved when designing a wireless application, but we need to determine if ADTRAN meets the initial needs of the customer.

Wireless Application Example	***Suggested TRACER Solution***
200 yard path for 14 Mbps data and single T1 for Voice	TRACER 6000 series with Quad Ethernet Bridge Module and Quad T1 Module
5 mile path for 45 Mbps data (Layer 2 bridged)	TRACER 5045

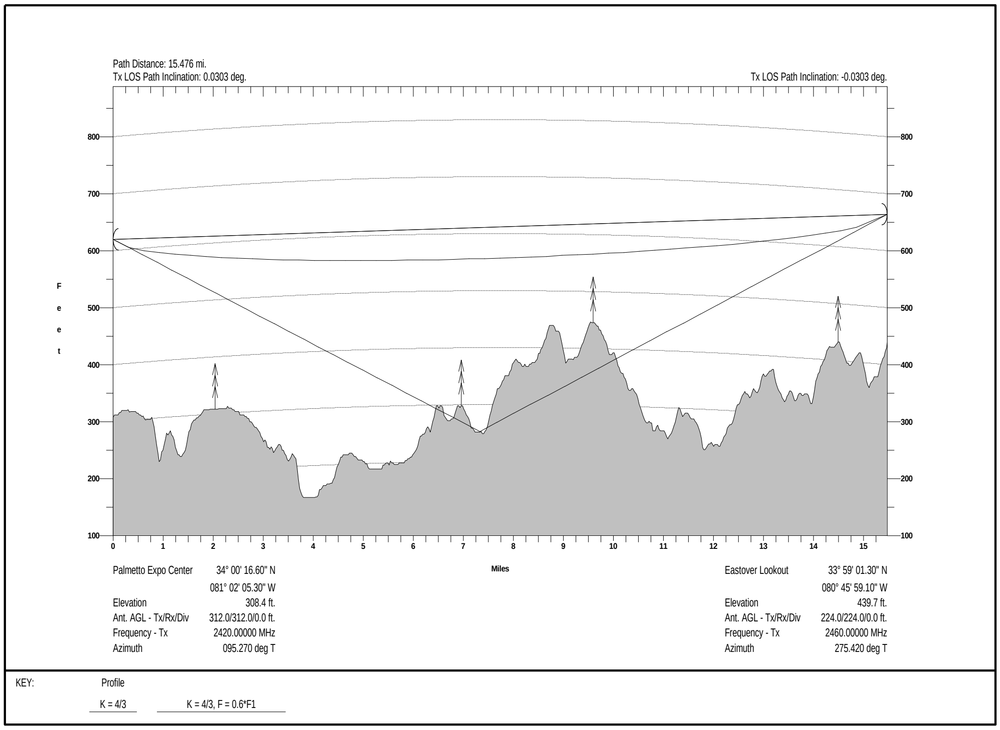
10 mile path for 10 Mbps data and 2xT1 for voice	TRACER 6000 series with Quad Ethernet Bridge Module and Quad T1 Module
20 mile path for 8xT1 backhaul	TRACER 6000 series with two Quad T1 modules
30 mile path for 2xT1	TRACER 6000 series with single Quad T1 module
10 mile path for DS-3 or >8xT1	TRACER 4205 and if > 8xT1, use MX2800 M13 Mux
50 mile path for 4xT1	TRACER 6000 series with Quad T1 module in "Intermediate Hop" Config
15 mile path for 2/4 wire E&M/TO for 2-way radio PTT	TRACER 6000 series w/Quad T1 module and TSU Mux with E&M/TO modules.
Multiple Hops for backhauling Cellular sites and dropping out services at each site	TRACER 6000 series or TRACER 4205 and the MX3 or MX4 multiplexers

These are just a few examples to consider. As you can see, there are numerous applications that we can support. If you have identified that ADTRAN has a product fit for you, then move on to step 2 to validate the sites and path performance.

Step 2. Validate the sites and path performance

From the examples illustrated above, you can see that paths can be very short or very long. Regardless of the path distance, you still have to verify that proper clearance is there and no obstructions are present in the path. If the proposed path is 1-2 miles or less, then typically you can stand on one rooftop and see the other rooftop. The point being, it would not require any path analysis software to be used to analyze topographical data. You should be able to see the terrain and any obstructions that would hinder the path. When your path is greater than 1-2 miles, it is best to use path analysis software. These tools use detailed 1 second terrain data and the Latitude and Longitude coordinates of each site to produce a graphic illustration of the path, terrain, and Fresnel zone (an elliptical zone between the two antennas). The rule is that 60% of the first fresnel zone must be free and clear of all obstructions. These tools allow you to insert obstructions (trees, signs, buildings) into the path to ensure that the fresnel zone has proper clearance. From using the tool, you will obtain the Above Ground Level (AGL) antenna height and actual path distance necessary to successfully deploy your proposed link. Other concerns, such as Reflective Paths, can be addressed with these tools to further ensure a proper design. If you design it properly and install it properly, then it should work properly.

This is a good place to let you know that ADTRAN can provide Street Atlas Maps, Path Profiles, and Link Analysis to assist with your proper design. If you know the Latitude and Longitude coordinates, then that is great. If not, you can get a portable GPS receiver and visit each location to record those values. If you know the actual Street Addresses, then provide those and, in most instances, we can identify the LAT / LONG coordinates of each site. We will also need to know of any obstructions that you can identify in the path and any existing rooftop / tower heights we have to work with as possible antenna location. Here is an example of a Path Profile generated from our Microwave Analysis Software.

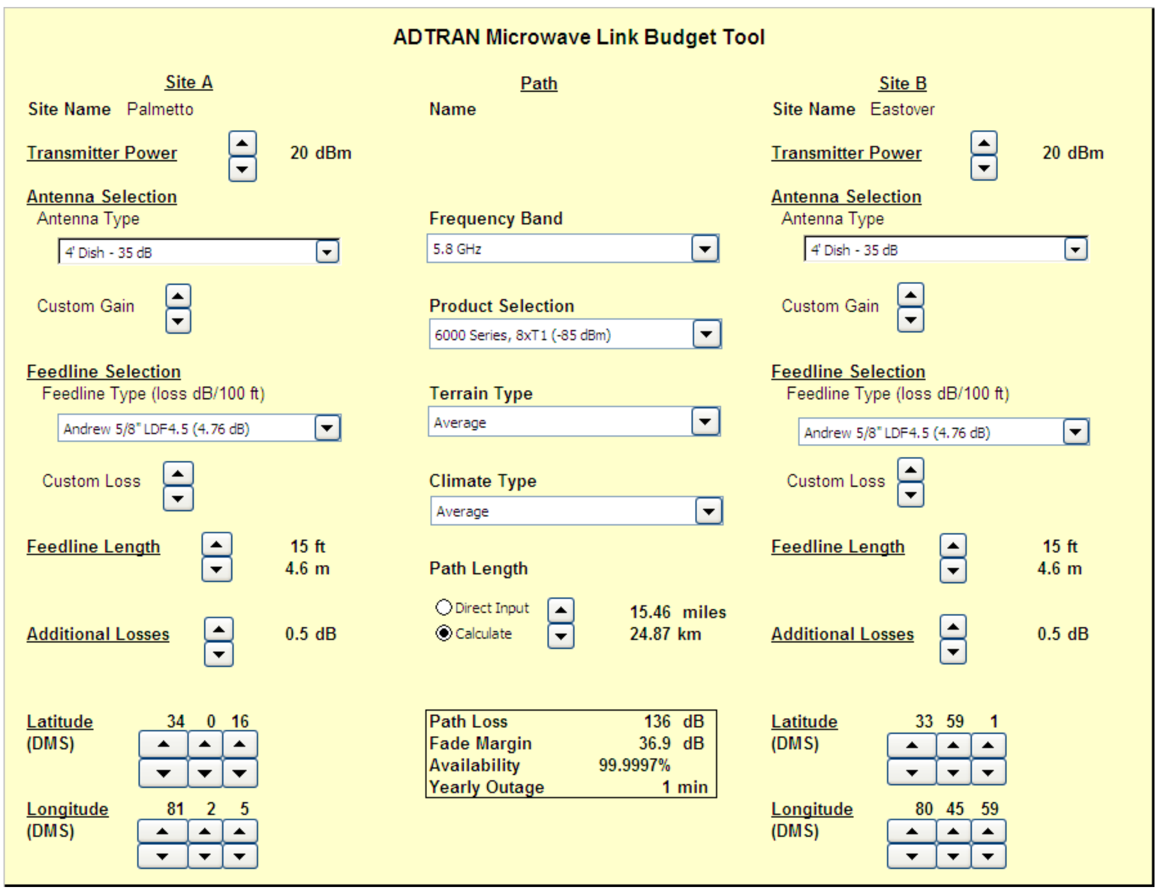


This Path Profile illustrates Site A on the left and Site B on the right. The first fresnel zone is displayed as the curved line between the two sites showing the critical area of space that the microwave energy occupies. You can also see the reflective path illustrated on the path profile. In this case, the reflective path is acceptable since it is absorbed by the terrain to prevent destructive multipath. Once the Path Profile is completed and acceptable, then move on to step 3 to begin your Link Analysis and Planning. This is where you will utilize the AGL Antenna Heights and Path Distance.

Step 3. Link Analysis and Planning

The ADTRAN Wireless Design Engineers have created the ADTRAN Link Planner Analysis Tool, which is available on the public web site for everyone to use.

http://kb.adtran.com/ . It is an EXCEL file that can be used from the website or downloaded to your laptop for independent use. When using the Link Planner Analysis Tool, you can manipulate all the variables associated with antenna size and associated gain, feedline type and length, radio Tx power, and path distances to achieve acceptable performance results. Acceptable performance results are generally a path availability of 99.999% and a fade margin of 30 dB or greater. It is very important to know the maximum feedline length expected from the antenna to the location of the radio, which may be a communications room or outdoor enclosure. As you select and change all the variables for your path design, the tool automatically calculates the performance results. The tool also allows User Selectable input if your desired choice is not designed into the Tool. Be sure to account for any dB loss associated with connectors and surge protectors. Here is an example of the Link Planner Analysis Tool :



ADTRAN Microwave Path Budget Summary

Path Name	0	
Path Length	15.46	miles
Frequency	5.8	GHz
Path Loss	-135.7	dB

	Site A		Site B	
Site Name	Palmetto		Eastover	
Latitude	34.0	deg	34.0	deg
Longitude	81.0	deg	80.8	deg
Rx Sensitivity	-85.0	dBm	-85.0	dBm
Transmitter				
Transmitter Power	20.0	dBm	20.0	dBm
Tx Feedline Loss	-0.7	dB	-0.7	dB
Additional Tx Plant Loss	-0.5	dB	-0.5	dB
Tx Antenna Gain	35.0	dBi	35.0	dBi
Tx Power	53.8	dBm EIRP	53.8	dBm EIRP
Receiver				
Far End Transmitter Power	53.8	dBm EIRP	53.8	dBm EIRP
Rx Antenna Gain	35.0	dBi	35.0	dBi
Rx Feedline Loss	-0.7	dB	-0.7	dB
Additional Rx Plant Loss	-0.5	dB	-0.5	dB
Rx Signal Level	-48.1	dBm	-48.1	dBm
Fade Margin	36.9	dB	36.9	dB
Availability	99.9997%		99.9997%	
Outage Time	1.4	min	1.4	min

This Link Analysis illustrates using the TRACER 6200/6320 5.8 GHz Split System. This is why you see 15' of "RF" Feedline being used. There is minimal impact to the Link Analysis calculations when using the Split System because the longer feedline run between the indoor unit and outdoor unit is an Intermediate Frequency (IF) of 140/280 MHz, as opposed to 5.8 GHz RF. If you design to the ADTRAN maximum specifications for the IF feedline of 600 feet of ½" or 350 feet of RG-8, then you will have an acceptable design. If using the other ADTRAN TRACER 4000, 5000, or 6000 series Integrated Systems, then you will need to design properly for a long 2.4 GHz or 5.8 GHz RF Feedline cable run.

Once your Link Analysis is completed and the Performance Results are acceptable, then move on to Step 4 to put your Bill of Materials together.

Step 4. Bill of Materials

ADTRAN designs, manufacturers, and supports the TRACER Family of Microwave Radios. To purchase TRACER or any of the items list below, we ask that you contact and utilize the expertise of an ADTRAN approved Wireless Reseller or Distributor.

www.adtran.com/wheretobuy (also see FAQ at the end of the guide)

Typical Items needed for a TRACER Installation:

1. Frequency Plan A and Frequency Plan B Radio
2. AC Power Supply if needed
3. ISM 2.4 GHz or 5.8 GHz Antennas (w/ N Series Female Connectors)
4. 50 Ohm Low Loss Coax Cabling or Waveguide
5. N Series Male Connectors
6. Lightning Surge Suppressor
7. Grounding Kits
8. Weatherproofing Kits
9. Cable Ties

All these items are typically available through the ADTRAN Wireless Reseller or Distributor. The following information will provide you some of the Industry Manufacturer options. Here are some links that may be useful to you to research some of the ancillary items. There are many other than the ones listed below.

www.commscope.com/andrew/eng/index.html
www.radiowavesinc.com
www.timesmicrowave.com
www.tripointglobal.com
www.rfsworld.com

5.8 GHz ANTENNAS

Manufacturer	Model	Style	Size	Avg Gain	List Cost
Andrews	P2F-52-N7A	Parabolic	2 foot	29.4 dBi	$790.00
Andrews	P3F-52-N7A	Parabolic	3 foot	33.4 dBi	$1080.00
Andrews	P4F-52-N7A	Parabolic	4 foot	34.9 dBi	$1620.00
Andrews	P6F-52-N7A	Parabolic	6 foot	37.6 dBi	$2857.00
Andrews	P8F-57W-N7A	Parabolic	8 foot	41.2 dBi	$3200.00
Andrews	FPA5250D06-N	Flat Panel	.5 foot	18.5 dBi	$468.50
Andrews	FPA5250D12-N	Flat Panel	1 foot	23.6 dBi	$811.20
Andrews	FPA5250D24-N	Flat Panel	2 foot	28.5 dBi	$1655.27
Andrews	PX2F-52-N7A	Dual Polar	2 foot	29.4 dBi	$1200.00
Andrews	PX3F-52-N7A	Dual Polar	3 foot	33.4 dBi	$1400.00
Andrews	PX4F-52-N7A	Dual Polar	4 foot	34.9 dBi	$2170.00
Andrews	PX6F-52-N7A	Dual Polar	6 foot	37.6 dBi	$3825.00
Radiowaves	SP1-5.2	Parabolic	1 foot	22.5 dBi	$450.00
Radiowaves	SP2-5.2	Parabolic	2 foot	29 dBi	$650.00
Radiowaves	SP3-5.2	Parabolic	3 foot	32 dBi	$1160.00
Radiowaves	SP4-5.2	Parabolic	4 foot	34.8 dBi	$1575.00
Radiowaves	SP6-5.2	Parabolic	6 foot	37.9 dBi	$2090.00
Radiowaves	SP8-5.2	Parabolic	8 foot	40 dBi	$3350.00
Pacific Wireless	GD5x	Grid Parabolic	Up to 3 foot	Up to 29 dBi	$55.95 - $79.95

NOTE: Prices listed above are from published material available at the time of this printing and are subject to change without notice. Individual quotations may vary.

2.4 GHz ANTENNAS

Manufacturer	Model	Style	Size	Avg Gain	List Cost
Andrews	P2F-23-N7A	Parabolic	2 foot	21.6 dBi	$900.00
Andrews	P4F-23-N7A	Parabolic	4 foot	27.3 dBi	$1710.00
Andrews	PL6F-23-N7A	Parabolic	6 foot	30.8 dBi	$2120.00
Andrews	PL8F-23-N7A	Parabolic	8 foot	33.4 dBi	$3130.00
Radiowaves	SP1-2.4	Parabolic	1 foot	14 dBi	$450.00
Radiowaves	SP2-2.4	Parabolic	2 foot	21.3 dBi	$650.00
Radiowaves	SP3-2.4	Parabolic	3 foot	24.3 dBi	$1160.00
Radiowaves	SP4-2.4	Parabolic	4 foot	27.3 dBi	$1575.00
Radiowaves	SP6-2.4	Parabolic	6 foot	30.3 dBi	$2090.00
Radiowaves	SP8-2.4	Parabolic	8 foot	33.2 dBi	$3350.00
Radiowaves	G3-2.4NF	Grid	3 foot	24.5 dBi	$1490.00
Radiowaves	G4-2.4NF	Grid	4 foot	27 dBi	$1695.00
Radiowaves	G6-2.4NF	Grid	6 foot	30.3 dBi	$2690.00

NOTE: Prices listed above are from published material available at the time of this printing and are subject to change without notice. Individual quotations may vary.

50 OHM LOW LOSS COAX FEEDLINE:

Manufacturer	Model	Size	2.4 GHz dB loss per 100’	5.8 GHz dB loss per 100’	List Cost
Andrews	FSJ1-50A	¼” Superflex	9.37	16.1	$1.54
Andrews	LDF1-50	¼”	6.60	11.5	$1.25
Andrews	FSJ2-50	3/8” Superflex	6.47	11.3	$2.40
Andrews	LDF2-50	3/8”	5.60	9.79	$1.98
Andrews	FSJ4-50B	½” Superflex	5.83	10.5	$3.47
Andrews	LDF4-50A	½”	3.52	6.11	$2.43
Andrews	LDF4.5-50	5/8”	2.65	4.76	$4.57
Andrews	LDF5-50A	Old 7/8”	2.02	**N/A**	$5.89
Andrews	AVA5-50	7/8”	1.90	**N/A**	$5.89
Times Microwave	LMR-240	¼”	12.9	20.4	$0.65
Times Microwave	LMR-400	3/8”	6.8	10.8	$0.88
Times Microwave	LMR-600	½”	4.42	7.30	$1.74
Times Microwave	LMR-900	5/8”	2.98	4.90	$5.00
Times Microwave	LMR-1200	7/8”	2.26	**N/A**	$6.90

NOTE: Prices listed above are from published material available at the time of this printing and are subject to change without notice. Individual quotations may vary.

Notes:

- Consult the cable manufacturer or wireless distributor for the best N series male connector to use on your installation.
- Installing the connectors takes a special skill set and tools. Some manufacturers will terminate your cables for a small fee.
- You can also purchase short coax jumpers for your installation, which are already connectorized.
- If coax does not work for your application, then you will need to use Elliptical Waveguide (ex =Andrews EW-52 for 5.8 GHz apps and EW-20 for 2.4 GHz apps). Waveguide has very minimal loss and is used for extremely long feedline runs. You will need to consult the manufacturer for details on the Waveguide, Accessories, and Installation.
- Reference the TRACER 6000 datasheet for the specifications on the Intermediate Frequency (IF) cable run between the 6200 IDU and 6320 ODU. You are allowed 600’ on ½” or 350’ on RG-8 (can use ¼” if needed).

OTHER ANCILLARY ITEMS NEEDED FOR INSTALLTION:

Manufacturer	Item description	Model	List Price
Andrews	Weatherproofing Kit	221213	$19.94
Andrews	½" Coax Grounding Kit	SGL4-06B2	$17.15
Andrews	5/8" Coax Grounding Kit	SGL45-06B2	$20.41
Andrews	7/8" Coax Grounding Kit	SGL5-06B2	$20.41
PolyPhaser	5.8 GHz RF Lightning Surge Suppressor	LSXL	$100.00
PolyPhaser	2.4 GHz RF Lightning Surge Suppressor	PSXL	$100.00
PolyPhaser	IF Lightning Surge Suppressor	100-0628T-A	$100.00

NOTE: Prices listed above are from published material available at the time of this printing and are subject to change without notice. Individual quotations may vary.

EXAMPLE BILL OF MATERIALS (BOM) FOR A TRACER 5.8 GHz INTEGRATED SYSTEM INSTALLATION:

Description	Part #	Qty	List Price Each	Total List Price
TRACER 6420 with High Power Output (Freq. A)	12806420L2A	1	$4195.00	$4195.00
TRACER 6420 with High Power Output (Freq. B)	12806420L2B	1	$4195.00	$4195.00
TRACER Quad T1 Interface Module	1280040L1	2	$2350.00	$4700.00
TRACER Four port Ethernet Switch Module	1280050L1	2	$2350.00	$4700.00
TRACER AC Power Supply	1280650L1	2	$240.00	$480.00
Andrew 2 foot 5.8 GHz Standard Parabolic Antenna	P2F-52-N7A	2	$790.00	$1580.00
Andrews 5/8" 50 Ohm Foam Dielectric Coax Cable	LDF4.5-50	200'	$4.57 per foot	$914.00
Andrews 5/8" N Series Male Connector	L4.5PNM-RC	4	$48.50	$194.00
Andrew 6 ft Male to Male ½" Coaxial Jumper Assembly	L4A-PNMNM-6	2	$98.30	$196.60
Andrew SureGround Grounding Kits for 5/8" (min of 3 per line)	SGL45-06B2	6	$20.41	$122.46
Andrew Connector/Splice Weatherproofing Kit	221213	3	$19.94	$59.82
PolyPhaser 5.8 RF Lightning Surge Suppressor	LSXL	2	$94.95	$189.90
PolyPhaser Adapter Kit for LSXL	BFN Adapter	2	$7.95	$15.90

NOTE: Prices listed above are from published material available at the time of this printing and are subject to change without notice. Individual quotations may vary.

FREQUENTLY ASKED QUESTIONS:

- ***Are the T1 interfaces on the TRACER Radios and Modules DS-1 or DSX-1?***
    a. All of the T1 interfaces are DSX-1 level specifications. They are intended to connect to customer equipment such as PBX, Router, etc. If you need to connect a TELCO DS-1, then you will need a CSU such as the ADTRAN T1 CSU ACE.

- ***What different power sources do the TRACER radios support?***
    a. All TRACER radios are designed for DC Power to support +/- 21 to +/- 60 VDC. We also have an optional Auto-Ranging AC Power Supply 1280650L1 if needed.

- ***Is the reliable performance of the TRACER wireless radios affected by rainfall, snow, and Ice?***
    a. No, rainfall attenuation is only an issue at 10 GHz and higher. The TRACERs operate at 2.4 GHz and 5.8 GHz, so the impact is little to none. The main concern about snow and ice is the feedhorn on the parabolic antennas. It is suggested that you use a Radome cover on your parabolic antenna to prevent those issues.

- ***Can you use two ADTRAN TRACER Wireless Radios at each location on the same path?***
    a. Yes, you can either use the same frequency radios on Dual Polarized antennas or you can use different frequency radios on Dual Band antennas.

- ***Do any of the TRACER Wireless Radios support encryption?***
    a. Yes, the ADTRAN TRACER 6000 series provide 3DES encryption that can be utilized for banking, medical, and other general security applications. There would be no worse than 100 microseconds of delay using the 3DES encryption option.

- ***Do the ADTRAN TRACER radios have multiple channel plans?***
    a. Yes, the TRACER 6000 series radios have three software selectable channel plans. In the 5.8 GHz radios, there are three NON-Overlapping channel plans. In the 2.4 GHz radios, there are two NON-overlapping and one Overlapping channel plan.

- ***What is the Maximum diameter of the Coax feedline that can be used on a TRACER 5.8 GHz wireless radio?***
    a. 5/8"" is the maximum coax that can be used on a 5.8 GHz system. If a larger coax is used, the RF signal will be improperly transmitted and could possibly cause damage to the transmitter if reflected back.

- ***What security concerns should I be aware of using the ADTRAN TRACER Wireless radios?***
    a. Unlike the 802.11x standards, the TRACER radios incorporate various multiplexing, scrambling, coding, and modulation schemes that make it virtually impossible to intercept the signal.

- ***What is the Tx Power on the TRACER wireless radios?***
    a. Prior to October 2005, all TRACER products transmitted at +20dBm. In Fall 2005 the TRACER 6410 2.4 GHz Modular Radio with a transmit power of +27dBm was released. In January 2006, ADTRAN released the new 2nd generation TRACER 6420 5.8 GHz Modular Radio with a transmit power of +24dBm.

- ***What are the different types of management access for the TRACER radios?***
    a. The TRACER 4205 and 5045 series radios can be accessed via the DB-25 RS-232 Serial Port. All of the TRACER 6000 series radios can be accessed via the DB-9 RS-232 Serial Port or you can Telnet to the 10/100 Management Port.

- ***Can a High Power TRACER 6000 Radio be used on a path with a Standard Power TRACER 6000 Radio?***
    a. This would only apply to the 5.8 GHz TRACER 6000 series. All of the TRACER 5.8 GHz 6000 series radios use the same modulation scheme. The Tx Power would only be a consideration with your Path Engineering process to obtain acceptable performance results. So, a TRACER 6200/6320 Split System (+20 dBm) could be used on a path with a TRACER 6420 L2 (+24 dBm). Also a TRACER 6420 L1 (+20 dBm) could be used on a path with a TRACER 6420 L2 (+24 dBm).

- ***Are there any FCC Rules concerning Tx Power when using 2.4 GHz radios on a path?***

  a. Yes, FCC Rules Part 15, Subpart 247 allow for a maximum power of 1 watt (30 dBm) into an antenna of a gain less than or equal to 6 dBi. The 1 watt maximum power must be reduced by 1 dB for every 3 dB of antenna gain See the table below for an illustration:

Output Power (dBm)	Maximum Antenna Gain (dBi)	Maximum EIRP (dBm)
27	15	42
26	18	44
25	21	46
24	24	48
23	27	50
22	30	52
21	33	54
20	36	56

- ***Who are ADTRAN's primary Wireless Distributors?***

  - Walker and Associates
    http://walkerfirst.com/
    1-800-925-5371
  - KGP Logistics
    http://www.kgplogistics.com/
    1-800-755-1950
  - Power and Tel
    http://www.ptsupply.com/
    800-238-7514

- ***Who do I contact for assistance with my Wireless Application?***

  a. ADTRAN EN Pre-Sales Applications Engineering Group
     - 800-615-1176
     - applications.engineering@adtran.com

  a. Andre'Ausbon (Wireless Path Engineering Specialist)
     - 800-615-1176 x8134
     - andre.ausbon@adtran.com