

The Proving Ground: Our Colorado Springs RF Lab

A VALMONT® TELECOM CAPABILITY OVERVIEW



Background

As wireless technology has progressed from 1G to 5G, the usable spectrum has expanded to support rapidly increasing data demands driven by AI, cloud computing, and other emerging technologies. This growth in frequency usage introduces new challenges for the telecommunications industry, particularly in interference mitigation and antenna concealment.

In response, ConcealFab® has significantly enhanced its anechoic chamber and radio frequency (RF) test capabilities over the past several years to ensure signal integrity with its products. These test resources and in-house expertise have been instrumental in qualifying the performance of the PIM Shield product portfolio and identifying RF-transparent materials for small cell concealments.

Following ConcealFab®'s acquisition by Valmont® in 2022, these capabilities have also been leveraged to further strengthen Valmont® Telecom's other product line brands. The RF tests summarized below routinely guide new product development and underscore their importance to overall system performance. This RF testing is conducted for ConcealFab®'s internal research and product development only — ensuring we deliver quality concealments and low-PIM components to our customers — and is not a testing service offered to external parties.



A full measurement suite covers near- and far-field transmission loss, antenna patterns, and radiated PIM from 0.7 to 40 GHz, showing how materials and geometry shape RF performance.



The same lab anchors quality control, screening absorptive, reflective, and RF-transparent materials before they reach the production floor to protect field performance.

100+

PRODUCTS PIM-QUALIFIED

0.7–40 GHz

FREQUENCY RANGE TESTED

75+

MATERIAL BATCHES SCREENED SINCE 2020

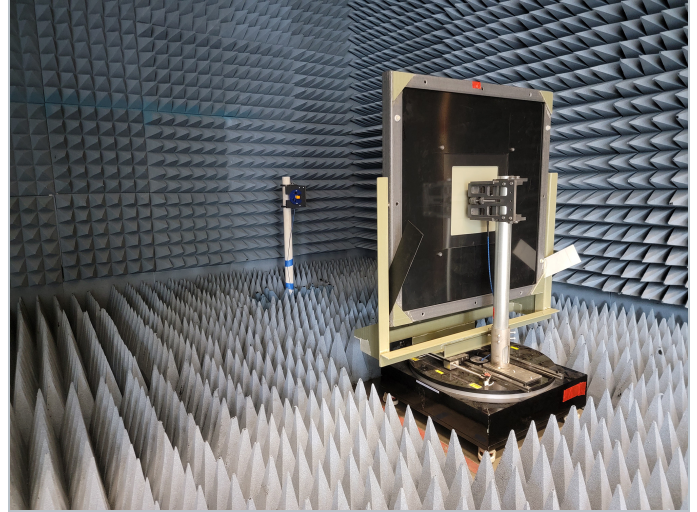


01

Near-Field Transmission-Loss vs. Distance vs. Frequency (LvDvF)

What it Does

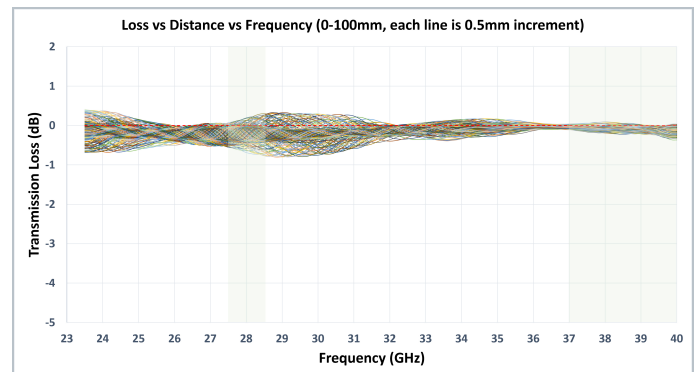
- Measures the transmission-loss versus distance versus frequency (LvDvF) of concealment materials held in the near-field of the antenna, capturing how the material attenuates a signal as both its spacing and the operating band change.
- The material-under-test is mounted in a fixture and stepped away from the antenna in fine increments of typically 0.5 mm, while loss versus frequency is logged automatically at every position.
- The complete sweep produces a distinctive “cyclone” plot that shows how sensitive a material’s transmission-loss is to its exact proximity to the antenna in the reactive near-field.
- Coverage spans a broad 0.7 to 40 GHz, reaching from legacy cellular bands through today’s millimeter-wave 5G frequencies.



Near-field loss vs. distance vs. frequency (LvDvF) set-up with sample.

Why it Matters

- Identifies the best concealment material and thickness for a given frequency to achieve maximum RF transmission with minimum reflection, even when packaging constraints force the material to sit very close to the antenna.
- Preserving that performance is critical to maximum antenna range and low interference for the wireless carrier, which translates directly into more reliable connectivity for end-users on the network.



Example millimeter-wave LvDvF plot: clearWave material test data.

Actualized Payoffs

- Led to the creation of ConcealFab®’s proprietary RF Material Selection Matrix, which rates the RF performance of candidate materials by frequency and thickness to guide the engineering design of antenna concealments.
- Directly enabled the clearWave concealment line and other RF-transparent options now used across ConcealFab®’s small-cell concealments and government shelters.
- Informed and validated the engineering design of Valmont® Larson’s tree and natural concealment products.

FREQUENCY				Thermoplastic A				FRP				ClearWave				Plastic B
Name	Band #	Category	Frequency (MHz)	1.57 mm	3.18 mm	4.75 mm	6.35 mm	3.18 mm	6.35 mm	3.0 mm	3.3 mm	4.06 mm	6.1 mm	3.18 mm		
700	12	Low Band	699-746	1	1	1	1	1	1	2	1	1	1	1	1	1
700	17	Low Band	704-746	1	1	1	1	1	1	2	1	1	1	1	1	1
700	13	Low Band	746-787	1	1	1	1	1	1	2	1	1	1	1	1	1
700	14	Low Band	758-798	1	1	1	1	1	1	2	1	1	1	1	1	1
850	5	Low Band	825-894	1	1	1	1	1	1	2	1	1	1	1	1	1
AWS	66 (a)	Mid Band	1710-1780, 2110-2180	1	1	3	4	4	5	1	1	1	1	1	1	1
PCS	2	Mid Band	1850-1910	1	1	2	3	3	4	1	1	1	1	1	1	1
PCS	25	Mid Band	1930-1990	1	1	3	3	3	4	1	1	1	1	1	1	1
2.5G	40, 41	Mid Band	2305-2360, 2495-2690	1	1	2	4	4	5	1	1	1	1	1	1	1
CBRS	48	CBRS	3550-3700	1	3	4	4	4	5	1	1	1	1	1	1	2
C-Band	77	Mid Band	3700-3980	1	3	4	4	4	5	1	1	1	1	1	1	2
LAA	46	LAA	5150-5925	1	4	4	5	5	6	2	1	1	1	3	3	3
mmW	261/257	mmW	27500-28350 (28GHz)	5	1	5	1	4	5	3	3	3	4	1		
mmW	260	mmW	37000-40000 (39GHz)	4	5	3	4	5	5	2	3	4	1	4		

RF Material Selection Matrix: concealment thickness by frequency (subset shown).

Grading Criteria		
Max loss >=	Score	Description
0	1	Best
0.51	2	Better
0.71	3	Good
1.01	4	Poor
2.01	5	Bad

Max loss = 1/2 * loss var + avg loss

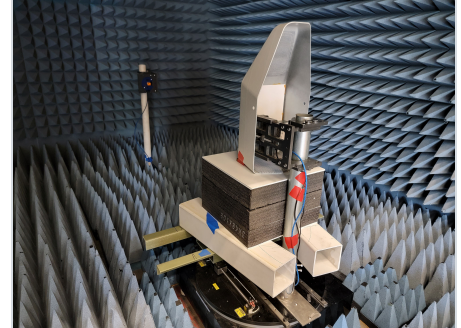
02 Antenna Pattern Testing

What it Does

- Measures the near- and far-field antenna patterns (gain versus theta versus frequency) produced when an antenna system radiates through a concealment.
- Test articles have included 28 and 39 GHz Anokiwave phased arrays as well as C-band antennas, each characterized both with and without concealments in place.

Why it Matters

- Concealments in the near-field can shift transmitted power, beamwidth, boresight error, and backlobe and sidelobe energy, all of which feed back into antenna range, cell size, and interference at the site.
- The testing reveals exactly how concealment geometry and material choice reshape the radiated pattern, so problems can be caught and corrected before deployment.



Antenna pattern test on shroud with clearWave window.

Actualized Payoffs

- Demonstrated and quantified the increased backlobe energy generated by FRP concealments and other highly reflective materials.
- Showed the measurable impact that seams and changes in concealment geometry have on the radiated pattern.
- Confirmed the efficacy of small, custom backlobe suppressors fitted to the antennas.

03 Radiated PIM Testing

What it Does

- Measures the peak power of external, third-order (IM3) passive-intermodulation (PIM) products generated by components subjected to dynamic mechanical stimulus under two 20 W test tones.
- Testing is carried out in the 700 and 1900 bands to the IEC 62037-8 standard, giving repeatable, industry-comparable results.

Why it Matters

- Non-linear components such as poorly designed cable-mounting brackets often sit at high-power basestation sites, where mechanical stimulus can cause them to generate PIM interference.
- That interference lands in the radio uplink, where it degrades the receive path and leads to dropped calls and other service disruptions for the carrier.



Radiated PIM test rig, IEC 62037-8, 700 and 1900 bands.

Actualized Payoffs

- PIM-qualified more than 100 products across our Valmont® PIM Shield portfolio of cable support components.
- Developed in-house tools and methods for identifying, troubleshooting, and mitigating both external and internal sources of PIM.
- PIM-qualified Valmont® Larson's full suite of Tree and Natural concealment mounting components.
- Improved the PIM performance of Valmont® Site Pro 1 antenna-mounting components.

04

Transmission-Loss vs. Frequency of Absorptive and Reflective Materials

What it Does

- Measures the transmission-loss versus frequency, from 1 to 17 GHz, of absorptive and reflective materials positioned in the near-field of the antenna.
- A deliberately small path-loss keeps each measurement comfortably within the dynamic range of the vector network analyzer (VNA).
- A tight, conductive seal between the material-under-test and the test-unit frame suppresses diffracted energy that would otherwise corrupt the reading.

Why it Matters

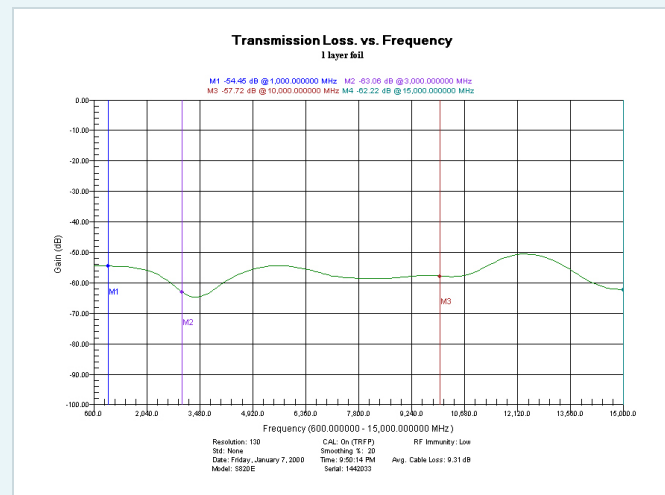
- Many applications need to deliberately block RF energy through reflection or absorption, whether for interference mitigation, eavesdropping prevention, or similar shielding requirements.
- The same setup is critical for the RF-quality inspection of PIM Shield Paint and Caulk and of the PIM Shield Absorber Kits before they are released.



Transmission-loss test, 1–17 GHz: PIM Paint on clearWave contacting gaskets around an AI window.

Actualized Payoffs

- Screened, approved, and released 30+ batches of absorptive and reflective material since 2022, ensuring the product reliability of the PIM Shield Absorber Kits, Paint, and Caulk as well as the government concealments built from those raw materials.
- Used in the routine RF inspection of raw materials such as PIM Shield paint, caulk, and absorbers, confirming their performance before any of it is released to market.
- Essential to the prototyping and development of the PIM Shield Absorber Kits, PIM Shield Foil and Blankets, PIM Shield Paint and Caulk, indoor power-reduction shrouds, custom RMS shelters, and government concealments.



Example transmission-loss vs. frequency plot for PIM foil.

05

RF Quality Inspections: Mobile Millimeter-Wave Transmission-Loss Test Rig

What it Does

- Measures the far-field transmission-loss versus frequency, from 23 to 40 GHz, of large, thin-panel materials under half an inch thick.
- The rig is mobile and built for quick-turnaround screening, so received panels can be checked in volume right on the production side.

Why it Matters

- Critical for the quick-turnaround RF-quality inspection of received raw materials destined for antenna concealments.
- Lets the team rapidly screen the RF-transparent clearWave materials and thin absorbers used in RF-blocking applications.
- Ensures only high-quality material reaches the production floor, so the assemblies shipped to customers stay reliable in the field.



Mobile far-field millimeter-wave transmission-loss test rig for RF inspections.

Actualized Payoffs

- Screened, approved, and released more than 75 high-volume batches of material since 2020, underpinning the reliable RF performance of commercial telecom and government concealments.
- Caught and quarantined at least three batches of incoming material that failed RF inspection since 2020, each resolved quickly through troubleshooting with the supplier.

Conclusion

ConcealFab® Valmont®'s radio frequency testing and anechoic chamber capabilities play a critical role in ensuring reliable, high-performance wireless infrastructure as networks continue to expand in frequency and complexity. Through a comprehensive suite of near and far field measurements, antenna patterns, radiated PIM testing, and material RF characterization, ConcealFab® systematically identifies and mitigates sources of performance degradation and interference across commercial and government applications. These capabilities have directly enabled the development of RF-transparent and RF-blocking concealments and PIM-friendly mounting hardware. Furthermore, ConcealFab® has robust quality control processes that safeguard field performance.



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