



Quad Plus[®]



Quad Plus *PipeGuard*

The *Future* of Steel Pipe Coating

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www.quadplus.com

(815) 724-2323

Quad Plus PipeGuard

Quad Plus *PipeGuard* is compliant with AMPP Standard TM21566. The Association for Materials Protection and Performance “AMPP;” adopted the Quad Plus solution as a foundational design for THz non-contact pipe coating.



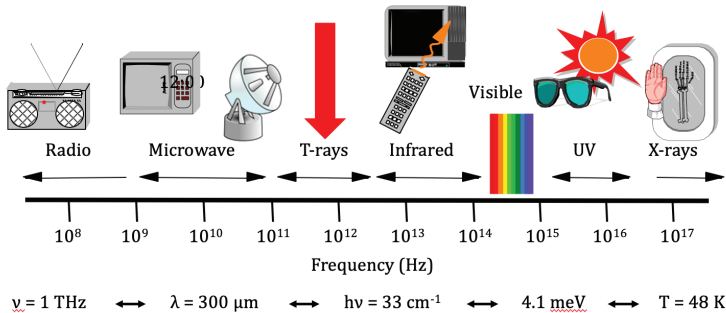
Our unique terahertz sensors measure single or multi-layer coating at line speed enabling on-line validation for release to specification. Process feedback control to spray systems and/or extruder control can be enabled for enhanced quality and economic return.

Applications include:

- ✓ FBE
- ✓ FBE & ARO
- ✓ 3LC - Copolymer Adhesive, HDPE, HDPP or Polyolefins
- ✓ SpiralWeld
- ✓ Corrugated

What is Terahertz (THz)?

Terahertz “THz” is the electromagnetic spectrum between far infrared and microwave. THz offers picosecond 10^{-12} sec. precision radar-like sensing options at frequencies ranging from 30GHz to 10THz and wavelengths from 1mm to 0.03mm.



Quad Plus THz Background?

Terahertz is an early adoption technology, offering improved quality, material savings, increased process utilization and potentially on-line release to specification. Quad Plus installed the first factory floor terahertz QCS system ten years ago; having since deployed more THz process solutions than other QCS providers combined.

Headquartered at New Lenox Illinois Quad Plus is 3rd largest USA system integrator so unlike many QCS manufacturers who sell what they have, we offer our clients metrology solutions open to global innovation. With regional sales and service resources located throughout the USA and Europe; QuadPlus offers a suite of innovative products and services to support customers’ gauging measurement and control requirements.

How Does THz Work?

An easy way to understand THz is by comparison to radar. Time-domain THz functions as a high precision radar sensor that measures time-of-flight “ToF”; detecting the time for a pulse to interrogate the target, reflecting from interfacial layer structures and return to the sensor. This is accomplished by using a femtosecond [10^{-15}] laser to generate picosecond [10^{-12}] pulse terahertz waveforms.

Waveform data streams are typically at kilohertz [1000k/second] enabling very fast web scan speeds and large data arrays >175,000/scan and >35,000/layer without averaging. To optimize performance, Quad Plus integrates a digital THz kHz sensor with a multicore PLC processor hosting >4,294,967,295 element high resolution array (32 bit, 4.29 billion). We do *not* need to dumb-down signal processing to emulate an analog device as some often do.

Application Considerations:

Terahertz sensors are 100% human safe, non-nuclear, non-ionizing and widely applicable when factory floor metrology and process control require rugged industrial solutions.

Features:

- ✓ Non-contact single layer or multilayer coating thickness
- ✓ Precision & gauge R&R better than magnetic, eddy current, x-ray, etc.
- ✓ THz coating range $10\mu\text{m}$ – 10cm
- ✓ Single-sided, reflection sensor – convenient low space profile
- ✓ Quad Plus environmental THz probe enclosure – temperature, humidity, fumes, water, and alignment
- ✓ THz is inherently immune to pipe wobble, dust, dirt, fumes
- ✓ Linear time calibration optional NIST traceable standard
- ✓ Small measurement spot size ~2mm
- ✓ Speed = 1000hz or 100hz applications dependent

Fig.1 Simplified 3LC Pipe illustration “ToF” principle:

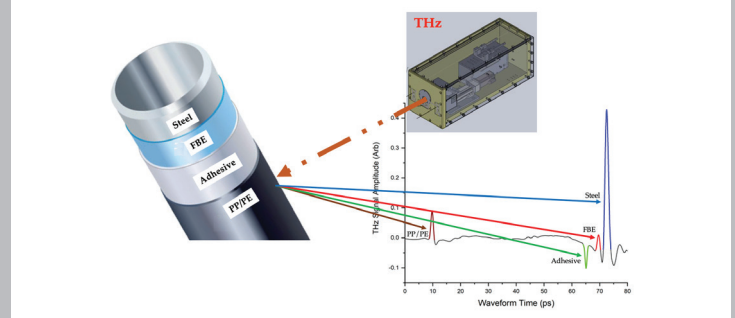
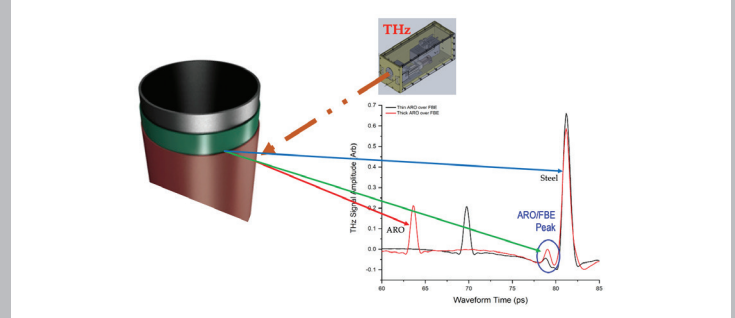


Fig.2 Simplified FBE/ARO Pipe illustration “ToF” principle:



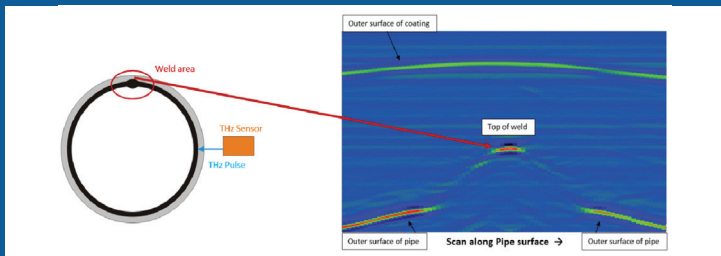
Application-matched THz pipe coating solutions:

To accommodate a wide range of pipe specialties, diameters and coating structures we offer two standard solutions.

1. Robotic deployment for wide OD range, corrugated, spiral-weld, 3LC

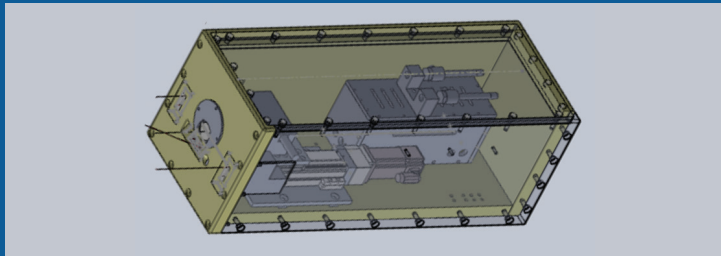


Automatic focus stabilization enables high lateral resolution of weld-seam coating structures.

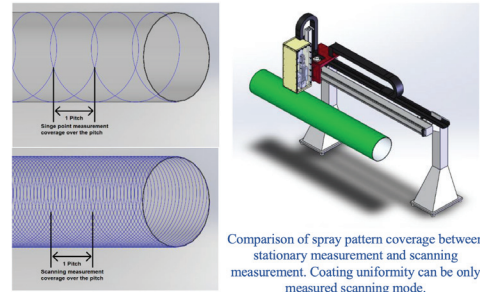


Quad Plus environmental THz probe

Integrated displacement sensors sustain optimal focus, pipe distance, lateral resolution, and signal compensation. Vortex coolers and thermocouples ensure operation at elevated temperatures. Inherent THz design ignores wobble, water, dirt, dust & coating back splash.

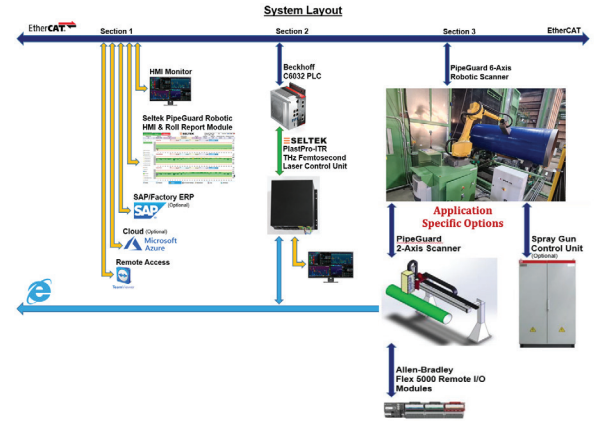


2. Pitch-scanner for long production runs of standard pipe with minimal OD range

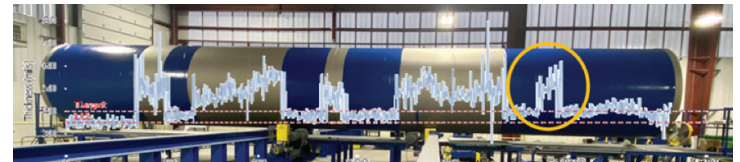


Comparison of spray pattern coverage between stationary measurement and scanning measurement. Coating uniformity can be only measured scanning mode.

Quad Plus "PipeGuard" is the complete solution for steel pipe coating. Designed and commissioned for your specific process requirements. Systemic integration to your business infrastructure.



Precision metrology and coater thickness control



- ✓ Data driven production quality control
- ✓ Minimal post-manufacture manual & zebra-pipe testing
- ✓ Pipe certification to specification
- ✓ Pipe thickness data map capable
- ✓ Reduced start-up & grade change
- ✓ Optimized powder coating consumption
- ✓ Competitive marketing advantage for your business

Parameter	Specification	Units	Comments
Type of Measurement	Time Domain THz		
Typical Measurement Period	0.25	sec	Minimum periods of 0.001 sec or 0.01 sec depending on TCU
Pass line tolerance	± 3 ± 6 ± 12 ± 40	mm	80ps Value is dependent on TCU scan window width 160ps 320ps 700ps
Measurement Rate	100 / 1000	meas/sec	1000 Hz - 80ps and 160ps 100 Hz - 320ps and 700ps
Basis Weight Range	3 to >20000	gsm	
Basis Weight Precision	0.2 to 1	gsm	Low gsm limit to high gsm limit
Caliper Range	0.025 to 8 0.025 to 17 0.05 to 40 0.05 to 100*	mm mm mm mm	80ps 160ps 320ps 700ps* *Slightly extended range is possible

Parameter	Specification	Units	Comments
Caliper Precision	± 0.1 to ± 0.5 μ	μm	Filter selection - Low Bandwidth to UltraHigh Bandwidth
Measurement Footprint	2	mm	Average focus spot size
CD Streak Resolution	0.5	mm	
Z-Axis Tolerance	± 6 ± 9 ± 12 ± 18	mm	Values listed are for 3 inch standoff sensor For 1 inch standoff sensor, divide values by 4 For 6 inch standoff sensor, multiply values by 2
Operating Temperature	0 to 50	C	Environmental enclosure available for operation outside this range
% Moisture			Application specific, please contact



Quad Plus®

Product Maintenance

We base our service offering on corrective and preventative maintenance that reduces downtime and helps you improve the process.

At Quad Plus, our support agreements offer

- ✓ System calibrations
- ✓ Preventative maintenance
- ✓ On-site repair

Complete package options are available with all travel and labor included.



Education and Training

Our training, included with the sale of each system, helps you increase productivity by optimizing the use of your instruments and expanding the skills of your operators.

Training topics covered:

- ✓ Basic Operation
- ✓ Calibration
- ✓ Routine Maintenance
- ✓ Troubleshooting

Quad Plus Certifications

- ✓ UL/CE are applicable to Luna

Following are now pending:

- ✓ AMPP/NACE/SSPC TM21566
- ✓ AWWA C222-18
- ✓ ASTM D7091



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