



SERIES NDT-RAM

RESONANT ACOUSTIC METHOD NDT

TYPICAL APPLICATIONS

- Powdered Metal
- Castings
- Forgings
- Metal Stampings
- Ductile/Gray Iron
- Ceramics
- Composites
- Additive Manufacturing
- Braze/Weld Joints
- Metal Injection Molding (MIM)

100% QUALITY INSPECTION

In the world of manufacturing today, the liability of shipping a defective part can be catastrophic for you, your customer, and the consumer. Non Destructive Testing via Resonant Acoustic Method (NDT-RAM) is designed to help you deliver fully inspected parts, economically and on time, giving you and your customers confidence in the quality of your parts.

The principle of Resonant Inspection is simple: every part has a unique resonant signature or pattern that reflects its structural integrity. A deviation from the expected signature or pattern can indicate the presence of a flaw. For example, a bell with a crack no longer has a clear ring or the ability to hold its tone. NDT-RAM Systems objectively discern between small differences in complex parts that produce far more tones than a bell.

The resonances of a structure are defined by its mass, stiffness and damping. These resonant frequencies can be measured in rigid materials including most metals, ceramics, and composites. NDT-RAM systems detect resonant frequency shifts which can be caused by imperfections such as cracks and voids, as well as variances in material properties, dimension, geometry, weight, density and manufacturing processes. NDT-RAM systems are ideal for testing a wide range of parts, including automotive parts, turbine blades, gears, tooling, fasteners, and more.

The Modal Shop has been the market leader in resonant inspection with over 20 years of industry and application experience and systems installed worldwide. We are dedicated to serving the manufacturing community with a commitment to Total Customer Satisfaction, bringing you the peace of mind that comes with 100% quality inspection.

SHIP ZERO DEFECTS

WHO NEEDS NDT RESONANT INSPECTION?

Part manufacturers or users of metal who...

- Have substantial inspection costs
- Require 100% parts inspection
- Desire to improve part quality
- Produce and/or use safety-critical parts
- Have customers demanding higher quality
- Have substantial scrap costs due to false rejects

INDUSTRY-LEADING FEATURES

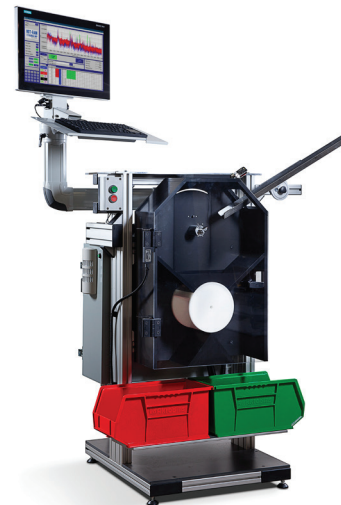
- **Frequency range up to 94kHz** for detection of higher frequency resonances associated with smaller defects
- **Up to 128k measurement resolution** improves defect detection capabilities
- **Integrated process compensation** makes managing lot to lot and normal process variation simple
- **One touch part changeover** simplifies part changes
- **Database connectivity** simplifies test reports and part traceability

A QUALITY SOLUTION

- **100% Inspection** - ensures that every part is objectively tested
- **No Prep** - part preparation not required for inspection
- **High Throughput** - approximately 0.5 - 3 seconds per part, typical*
- **Simple Interface** - simple to learn and use application software
- **Reduced Costs** - lowers operating expenses by eliminating consumables, eliminating quality recall / containment costs, and reducing scrap costs associated with false rejects
- **Industrial Package** - NEMA4 enclosure allows factory floor operation
- **Versatility** - same system can test many different parts
- **Durability** - NDT-RAM systems have been running 24 / 7 / 365 in the plant environment for over 20 years



RAM-AUTO



RAM-DROP

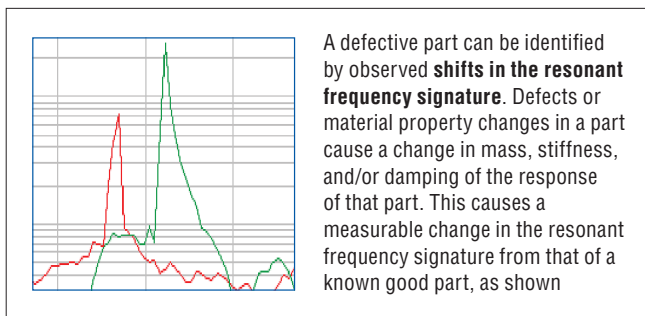
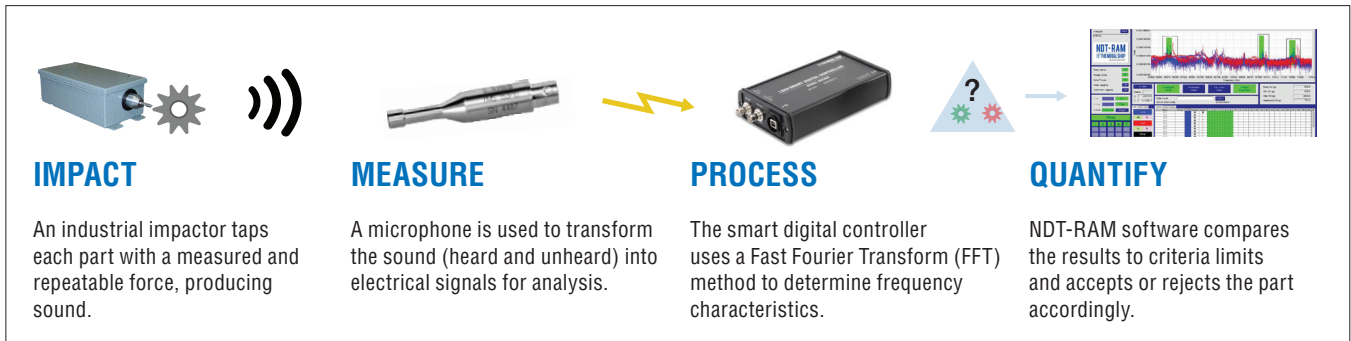


RAM-TEST-SEMI

NDT-RAM TECHNOLOGY

PASS / FAIL TESTING

The resonances of a structure are defined by its mass, stiffness and damping. These resonant frequencies can be measured in most rigid materials including metals, ceramics and composites. NDT-RAM systems detect frequency shifts which are caused by imperfections such as cracks, porosity and voids as well as variances in nodularity, dimension, geometry, weight, density and manufacturing processes.



PROCESS COMPENSATED RESONANCE TESTING

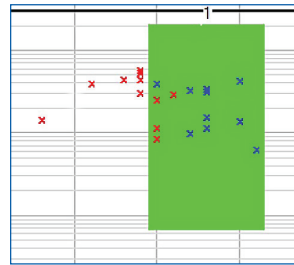


Figure 1: Frequency vs. amplitude (without RAM-PCRT)

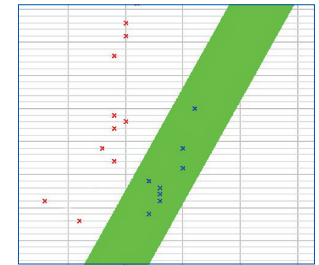
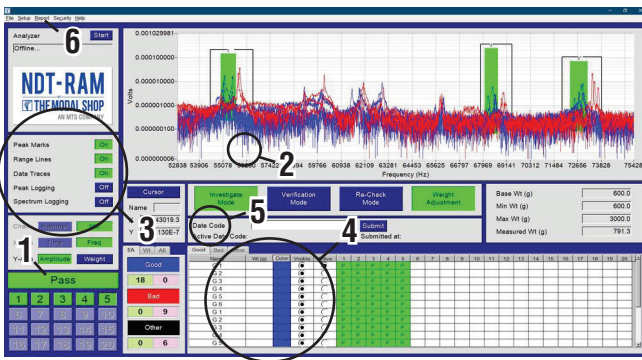


Figure 2: Frequency vs. Mass (with RAM-PCRT)

GRAPHICAL USER INTERFACE

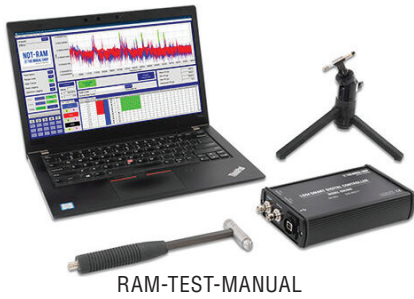


1. Clear indication of pass/fail by criteria range
2. Data shows color-coded spectra for good and bad parts against acceptable criteria ranges
3. Graphic features provide easy visual and data evaluation
4. Investigate Mode supports up to 1500 part spectra, labeled good, bad, or unknown
5. Customizable field for serial number, date/lot code, or other data to be recorded with part test results
6. Automatic storage of part test data with built-in report generation and statistical data review

In some manufacturing processes, process variation is normal and can result in minor, acceptable variation in the stiffness and mass of parts produced. This variation can cause a spread in the resonant frequency peaks of acceptable parts, potentially causing overlap between acceptable and defective part frequencies. In older resonance testing systems, this can cause an excess of false failures in order to ship ZERO defects.

Resonant Acoustic Method – Process Compensated Resonance Testing (RAM-PCRT)

- Applies a linear slope to the acceptance criteria to account for process variation (weight or temperature)
- Increases separation between good and defective parts
- Fails 100% of defective parts while reducing or eliminating false failures



RAM-TEST-MANUAL

NDT-RAM SYSTEMS

- 100% inspection of every part prior to shipment
- Ideal for in-line, automated, objective inspection
- In-line monitoring to improve process
- Fast throughput – up to 0.5 s per part, 1-3 s, typical*
- Adaptable to existing process automation
- Measurement range: 94 kHz or 20 kHz options
- Process compensation: mass or temperature RAM-PCRT**

RAM SYSTEMS					
AUTO	Fully automated system for turnkey in-line 100% inspection				
DROP	Fully automated system for high volume sort of small parts				
TEST-SEMI	Core NDT system components for implementation with existing automation				
TEST-FIXTURE	Semi-automated test station for manual part placement with automated testing				
TEST-MANUAL	Manual system for laboratory or spot checking use				
HOW WILL NDT-RAM BE USED IN YOUR FACILITY?	AUTO	DROP	TEST		
			SEMI	FIX	MAN
Turnkey Automation for Production	☑	☑			
Integration into New or Existing Production Line	☑	☑	☑	☑	
Operator Assisted Production Testing				☑	☑
R&D Quality Lab Offline Troubleshooting				☑	☑
Portable System for Field Testing					☑

* Test speed dependent on part size and system setup

** RAM-PCRT included in software, requires external sensors for implementation

NON-DESTRUCTIVE TESTING METHODS COMPARISON					
DEFECT TYPE	RAM RESONANT ACOUSTIC	ET EDDY CURRENT	MT/PT MAGNETIC PARTICLE	UT ULTRASONIC	RT RADIOGRAPHY
Cracks/ Chips/ Voids	■	■	■	■	▲
Material Properties	■	●	●	●	▲
Missed Operations	■	●	●	●	●
Structurally Integrity	■	■	■	■	■
Product Lot Variations	■	▲	■	■	■
Defect Location					
Surface (External)	■	■	■	■	●
Internal	■	●	●	■	■
Brazing/ Bonding/ Welding	■	●	●	▲	▲
Speed/Training/Cost					
Throughput	■	▲	▲	■	●
Training/ Certification	■	●	●	●	●
Total Costs	■	▲	▲	●	●
Automation Capacity					
Quantitative results	■	●	●	▲	●
Ease of Automation	■	▲	▲	●	●
Cost of Automation	■	▲	▲	●	●

■ Excellent ▲ Fair ● Poor