Ion Mobility Advanced Detector IONMAD 2025

Advanced Verification Technology Inc.

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1 ABSTRACT

This document outlines functionality, structure and key parameters of high-performance Handheld Ion Mobility Advanced Detector IONMAD 2025 produced by Advanced Verification Technology (AVT). IONMAD 2025 considerably outperforms all known devices in this class, both handheld and desktop models. Initial prototypes are available for evaluation.

Most of the key solutions are proprietary to AVT – US patent is pending.

2 ION MOBILITY HANDHELD TRACE DETECTOR.

2.1 GENERAL INFORMATION

Presented HHD is a highly integrated and energy efficient Drift Tube Ion Mobility Spectrum Analyzer IONMAD 2025 that detects traces of narcotics, explosives and other volatile substances. It supports both particle and vapour modes and capable of simultaneous dual mode detection of explosives and narcotics from a single sample. It uses a unique and highly reliable non-radioactive ionization source which does not require any licensing like traditional radioactive sources. Advanced fully regenerative air purification system minimizes ownership cost of the HHD even further. IONMAD 2025 has been designed to TSA specification for security and drug trafficking in passenger transportation, but it was evaluated for wide range of other applications such as cargo screening, medical diagnostics, security screening of large people gatherings etc.

Table 1. General Technical Specification of IONMAD 2025.

Parameter	Specification
Technology	Drift Tube Ion Mobility Spectrometry (DTIMS). Non-radioactive ionisation.
Sampling	Particle mode using swabs and vapor mode
Explosives detection	Military, commercial and home-made explosives including HMX, NG, PETN, RDX, TNT and others
Narcotics detection	Amphetamine, cocaine, heroin, ketamine, MDMA, methamphetamine, THC and others
Analysis time	6-10 seconds
Warm-up time	Less than 8 minutes
Connectivity	Gb Ethernet; 2x USB 2.0, Micro SD Card, WiFi&Bluetooth
Power	24VDC, 1.5A. Up to 6-hour full operation on a single charge of two hot-swappable Lithium-ion batteries *.
Data display	5" high resolution, anti-reflective, colour touch screen
Dimensions (LxHxW)	290x170x150mm
Operating temperature	-10 to +50°C (14 to 122°F)
Operating altitude	3,048m (10,000ft)
Operating humidity	0 to 95% non-condensing

Notes:
*Power consumption under nominal conditions for reference. Depends on mode of operation:

Mode of operation	Power, W
Idle ready, no battery charging	36
Idle ready, battery charging	80
Bakeout, no battery charging	42
Regeneration, no battery charging	27
Cold start plus battery charge, peak	115

HHD consists of advanced sample introduction, Dielectric Barrier Discharge (DBD) ionization system, high performance modular Reaction and Drift Chambers, novel low noise collector, high reliability ion gate, state of the art electronics for IMS conditioning, power management, data acquisition and processing.

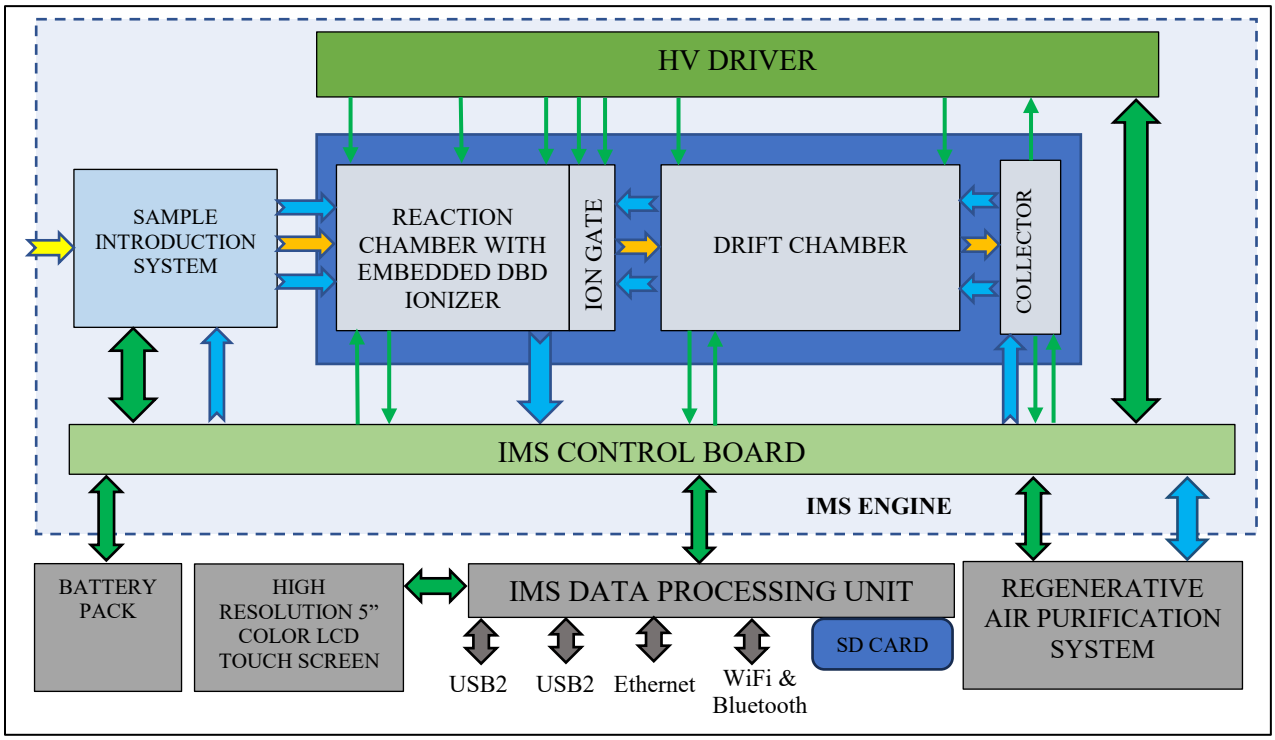

Figure 1. IONMAD 2025. Function Diagram.

Proprietary IMS High Voltage Driver (HVD) is fitted into a compact PCB that provides all voltages to control proprietary Reaction Chamber, Ion Gate and Drift Chamber, drives proprietary DBD Sample Ionizer and conditions ionic signal from proprietary Ion Collector. HVD operates in a fast polarity switching mode providing superior both short-term (within scan and scan to scan) and long-term stability.

IMS Control Board controls IMS Detector and Sample Introduction System based on user configurable method, manages Battery Pack and system power distribution, controls Air Purification System, acquires measuring data and communicate with IMS Data Processing Unit (IMS DPU).

IMS DPU controls 5" high resolution color touch screen LCD and provides communication with external devises, i.e. memory storage, PC, printer etc. HHD runs under Linux and provides versatile interfacing including Ethernet, USB, WiFi and Bluetooth.

Detector Application that runs on ARM processor provides advanced and very intuitive graphic user interface (GUI) that can be used either through the high-resolution touch screen or through a remote access when HHD is acting as a webserver. It supports multi-level and multi-user password protected access.

HHD employs innovative state of art data processing and detection algorithm based on pattern recognition with potential enhancement using AI.

2.2 KEY FUNCTIONAL PARAMETERS

Table 2. IONMAD 2025 Functional Parameters

Parameter	Operating range	Notes
Ambient operating temperature	-20C…+50C	
Drift voltage	+/-(1500…3000)V	Configurable*
Width of Ion Gating pulse	(20…1000)uS	Configurable

DBD pulse amplitude	+/-(1000..3500)V	Configurable
Number of Ionization Pulses	1…65536	Configurable
DBD Ionizer advance time	(10…5000)uS	Configurable with respect to the Gating Pulse.
IMS temperature	Up to +160C	Configurable. Proven performance at low temperature down to +80C for power saving
Desorption temperature	Up to +250C	Configurable
Signal quantization time	12.5uS	
Number of scans in a segment	1…40	Configurable

*Note: maximum drift voltage depends on required voltage across Reaction Chamber which is optimized for maximum sensitivity.

Programmable sample ionization allows for further optimization for specific timing on desorption profile for each polarity.
IONMAD 2025 allows to preconfigure multiple channels for quick identification of the targeted substances. Besides basic detection functionality, such as audio and visual signaling, HHD allows for logging extended reports or presenting 2D and 3D plots on HR Color LCD.
Advanced GUI allows for outstanding flexibility of operation, handling of the results and maintenance.

2.3 IONMAD 2025 Analytical Performance

All technology enhancements listed above allow for superior sensitivity of HHD and extremely low detection limit – refer to **Table 3**.

Table 3. Detection limits of IONMAD 2025 in comparison to the major players on the market.

Substance	AVT IONMAD 2025	Average Competitors
Cocaine	0.1ng	60ng
Heroin	1ng	80ng
Meth	0.1ng	40ng
TNT	0.25ng	1ng
PETN	0.05ng	3ng
HMX	0.3ng	4ng
NG	0.05ng	15ng

Sensitivity of HHD is far beyond TSA requirements and may have the following advantages:

1. Allow for further reduction of the gating pulse width to achieve better resolving power.
2. Smaller amount of sample can be desorbed which reduces contamination of the detector resulting in shorter down time for cleaning.
3. Wider selection of materials for sample swabs.

4. Softer ionization which in turns reduces generation of undesirable ions and provides better reliability of the DBD ionizer and its driver.
5. Lower operating temperature to save energy which is crucial for HHD.
6. Allows for direct vapor analysis without preconcentration.

3 LAYOUT OF HHD IONMAD 2025.

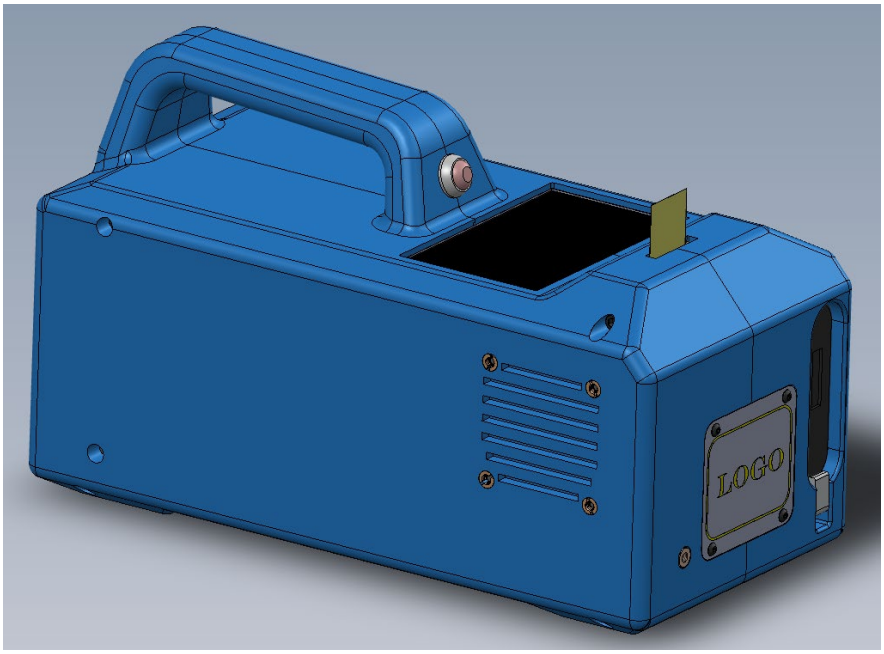

Figure 2. IONMAD 2025 – SolidWorks 3D isometric view.

4 CONTACT INFORMATION.

Advanced Verification Technologies Inc. is Toronto based company with broad experience in advanced electronics focused on Ion Mobility for the last 20 years.
Email: sirotech@rogers.com
Phone: 1-416-559-4964