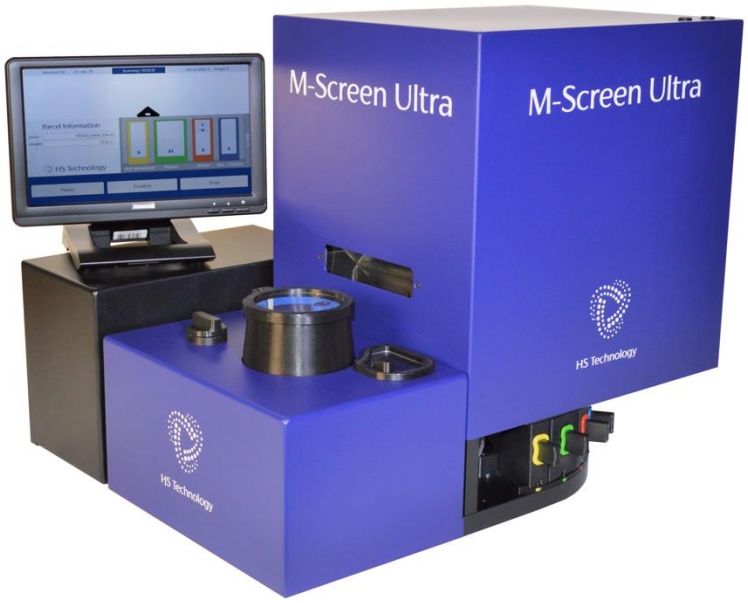
NATURAL DIAMOND COUNCIL

Universiteit Antwerpen

PROJECT ASSURE
DIAMOND VERIFICATION INSTRUMENT STANDARD
TEST RESULTS

Assessment Report for: HS Technology / M-Screen Ultra



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Testing ID Number: 2022-01
Report Date: May 24th, 2022
Approved by:

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Lab Manager

DIAMOND VERIFICATION INSTRUMENT

Manufacturer's Name: HS Technology
Instrument Model: M-Screen Ultra
Serial Number: MS21-003
Software Version: 3.2.1 (rev 16 June 2021)
Lab Manager: Quinten Van Avondt
Testing Manager: Cindy De Plukker

Manufacturer stated diamond verification instrument description and features:

- Automatic stone feed
- Automatic stone classification
- Automatic stone sorting

Manufacturer stated diamond verification instrument limitations:

- Loose stones
- Round brilliant stone shape
- Stone size of 1.0mm – 3.6mm (0.004 ct - 0.18 ct)
- Stone color of D to J
- Stone clarity better than SI2
- Difference in stone diameter within a test parcel may not exceed 0.5 mm

INSTRUMENT PERFORMANCE ASSESSMENT

ASSESSMENT CRITERIA

The ASSURE testing methodology and performance metrics are dependent on the operational capabilities of the diamond verification instrument being tested. These are defined by the following three categories:

Category 1 – Screen diamonds from synthetic diamonds. This category of device is intended for discrimination of diamonds from synthetic diamonds. It cannot distinguish diamonds from diamond simulants and therefore requires stones to be pre-screened to ensure no simulants are introduced into the device.

Category 2 – Screen diamonds from synthetic diamonds and diamond simulants. This category of device is intended for discrimination of diamonds from synthetic diamonds *and* diamond simulants. This device *cannot* distinguish synthetic diamonds from diamond simulants.

Category 3 – Screen diamond from synthetic diamonds from diamond simulants. This category of device is intended for discrimination of diamonds, synthetic diamonds, and diamond simulants from each other. This device *can* distinguish synthetic diamonds from diamond simulants.

Instrument performance for classifying the different kinds of stones tested was assessed against:

- ☐ Category 1: Diamond Verification Instrument Standard Part 1 – Diamond Verification Instrument for Screening Diamonds from Synthetic Diamonds (09 11 2021)
- ☒ Category 2: Diamond Verification Instrument Standard Part 2 – Diamond Verification Instrument for Screening Diamonds from Synthetic Diamonds and Diamond Simulants (09 11 2021)
- ☐ Category 3: Diamond Verification Instrument Standard Part 3 – Diamond Verification Instrument for Screening Diamonds, Synthetic Diamonds, and Diamond Simulants (09 11 2021)

as referenced in sections 7.3 and 7.4 of the Diamond Verification Instrument Standard – General Requirements for Evaluation Diamond Verification Instruments (09 11 2021). Any deviations from the Standard are noted below.

Notes:

The M-Screen Ultra has an upper stone size limit of 3.6mm. Stones with greater diameter than 3.6mm (33 out of 500) were removed from the PRIMARY Sample set prior to conducting performance testing.
The M-Screen Ultra design is optimized for smaller melee diamonds (1mm to 2mm). As a result, the speed testing measurements are based on the SMALLS sample set.

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DEFINITIONS

Diamond Accuracy	*Diamond* test stones correctly classified as *Diamond*.
Synthetic Diamond Accuracy	*Synthetic Diamond* test stones correctly classified as non-diamond (*Synthetic Diamond / Diamond Simulant*).
Diamond Simulant Accuracy	*Diamond Simulant* test stones correctly classified as non-diamond (*Synthetic Diamond / Diamond Simulant*).
Diamond Referral Rate	*Diamond* test stones classified as *Referral*.
Synthetic Diamond Referral Rate	*Synthetic Diamond* test stones classified as *Referral*.
Simulant Referral Rate	*Diamond Simulant* test stones classified as *Referral*.
Diamond False Positive Rate	Non-diamond test stones (*Synthetic Diamond / Diamond Simulant*) incorrectly classified as *Diamond*.
Synthetic Diamond False Negative Rate	*Synthetic Diamonds* incorrectly classified as *Diamond*.
Diamond Simulant False Negative Rate	*Diamond Simulants* incorrectly classified as *Diamond*.
Testing Speed	The average speed at which the diamond verification instrument evaluates the stones in the PRIMARY loose sample set, including set-up time (if any).
Operating Speed	For auto-loading diamond verification instruments only; the average speed at which stones are evaluated once the instrument achieves a steady-state. Does not include set-up time.

TEST STONE SETS USED FOR EVALUATION

Loose, Polished Stone Test Sets	Diamond	Synthetic Diamond	Diamond Simulant
Primary Sample Set (>2.0 mm, D-J color)	☒	☒	☒
Supplementary Smalls Sample Set (1.0-2.0 mm, D-J color)	☒	☒	☒
Mounted, Polished Stone Test Sets	**Diamond**	**Synthetic Diamond**	**Diamond Simulant**
Primary Sample Set (>2.0 mm, D-J color)	☐	☐	☐
Supplementary Smalls Sample Set (1.0-2.0 mm, D-J color)	☐	☐	

Notes:
In Primary loose sample set, stones greater than 3.6 mm diameter were excluded from testing due to upper size limit for this instrument.
This instrument cannot test mounted jewelry.

CLEANING PROCEDURE OF STONES PRIOR TO TESTING

Test stones sets are cleaned in an ultrasonic bath of isopropanol for 2 minutes and dried using an ionizer prior to testing to reduce grease and electrostatic charge, as per Section 8 of ASSURE Standard.

LABORATORY CONDITIONS AT TIME OF ASSESSMENT

Condition	Requirement	Actual
Temperature (°C)	18 to 25°C	21°C
Humidity (%)	50 to 65%	50%

RESULTS OF INSTRUMENT PERFORMANCE ASSESSMENT – LOOSE STONES

Performance Metric	Primary[1]	Uncertainty[2]	Smalls	Uncertainty[2]
Diamond accuracy (%)	98.3	0.0	98.3	0.3
Synthetic diamond accuracy (%)	N/A[3]	N/A	N/A[3]	N/A
Diamond simulant accuracy (%)	N/A[4]	N/A	N/A[4]	N/A
Diamond referral rate (%)	1.7	0.0	1.7	0.3
Synthetic diamond referral rate (%)	100.0[3]	0.0	100.0[3]	0.0
Diamond simulant referral rate (%)	100.0[4]	0.0	100.0[4]	0.0
Diamond false positive rate (%)	0.0	0.0	0.0	0.0
Synthetic diamond false negative rate (%)	0.0	0.0	0.0	0.0
Diamond simulant false negative rate (%)	0.0	0.0	0.0	0.0

Notes:
[1] Primary stone set deviates from the Standard as a reduced number of stones were analyzed; the Primary sample has a total of 500 mixed stones of which 467 stones were tested due to removal of stones greater than 3.6mm diameter.
[2] Uncertainty is expressed as absolute +/- range and reflects the consistency of the instrument's classification of stones for each of the three trials performed with the ASSURE sample.
[3] All Synthetic Diamonds reported to the "Referral" bin for this instrument.
[4] All Diamond Simulants reported to the "Out-of-spec" bin for this instrument.

INSTRUMENT TESTING SPEED ASSESSMENT

Testing Speed approximates the usage turnaround time that could be expected by a novice user of the diamond verification instrument and is determined by the time required to evaluate the performance of the diamond verification instrument on the Primary Loose stone test set:

- Testing Speed accounts for the time directly associated with stone assessment including loading stones, programming any applicable instrument measurement parameters, analyzing the stones, and segregating the analyses stones into respective instrument classified groups.
- Testing Speed does not include the time to initially warm-up the diamond verification instrument (if applicable) nor the

time to separate diamonds from synthetic diamonds for each of the instrument classified groups of analyzed stones.

- Testing Speed does not include time associated with interruptions to the testing process.

Diamond verification instruments that continuously load and analyze stones (i.e., autoloading diamond verification instruments) shall also be assessed for a steady-state Instrument Operating Speed.

- Operating speed is the number of stones that can be analyzed per hour while the diamond verification instrument is operating in steady-state.

Testing Speed, and instrument Operating Speed if applicable, are measured in triplicate. The mean value is reported in the Speed Test Results table below. The Uncertainty reflects the absolute +/- range of the results measured over the three trials.

SPEED TEST RESULTS

Category	Stones per hour	Uncertainty (stones/hr)
Testing Speed	8,526	308
Operating Speed [1]	13,706	802

Notes:
[1] Operating Speed is based on testing a mix of loose stones from the Smalls sample set with a diameter between 1.2mm and 1.4mm in accordance with manufacturer recommended use case for this instrument.

ADDITIONAL FINDINGS

********** End of Report **********

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Introduction:

The Characterization Report appendix provides additional information about the physical characteristics for the PRIMARY and SMALLS loose sample sets that were either classified by the instrument as Referrals or that were mis-classified (eg. diamond stones incorrectly classified by the instrument as being synthetic diamond). This appendix is only provided to the instrument manufacturer to provide greater insight into instrument performance and will not be published to the ASSURE directory.

All referral stones or mischaracterized stones from the three trials are included in the data tables. If a data table is not included in this appendix, it means that either the instrument performed flawlessly for that category, or that the category was not tested. The stone count figures (shown in brackets) are the total number for the three trials.

Data Table Definitions:

Diamond Referrals: Diamonds that were categorized as Referral.

Non-diamond Referrals: Synthetic Diamonds and Diamond simulants categorized as Referral.

Diamond False Positive: Synthetic Diamonds and Diamond Simulants incorrectly categorized as Diamond.

Synthetic False Positive: Diamonds and Diamond Simulants incorrectly categorized as Synthetic Diamond.

Simulant False Positive: Diamonds and Synthetic Diamonds incorrectly categorized as Diamond Simulant.

Notes:

Stone counts indicate the number of unique stones for a category from the three trials run.

Percentage values indicate the weighted average proportion from the three trials.

Nitrogen Aggregation (%IaB) reflects the proportion of atomic nitrogen present as B-centers (a carbon vacancy surrounded by four substituted nitrogen atoms) for mischaracterized diamonds.

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Diamond Referral Rate - PRIMARY

Category		Stone Type		Fluorescence Strength		Fluorescence Colour
Diamond	100.0%	Type I (1 stn)	16.7%	None	100.0%	
				Slight	0.0%	
				Moderate	0.0%	
				Strong	0.0%	
		Type II (5 stns)	83.3%	None	100.0%	
				Slight	0.0%	
				Moderate	0.0%	
				Strong	0.0%	

Category		Stone Type		Nitrogen Characterization Concentration (ppm)		Nitrogen Characterization Aggregation (%IaB)	
Diamond	100.0%	Type I (1 stn)	16.7%	<100	100.0%	0 - 30	100.0%
						30 - 70	0.0%
						>70	0.0%
				100 - 300	0.0%		
				300 - 600	0.0%		
				>600	0.0%		
		Type II (5 stns)	83.3%	<100	100.0%	0 - 30	100.0%
						30 - 70	0.0%
						>70	0.0%

Notes: Nitrogen Aggregation (%IaB) reflects the proportion of atomic nitrogen present as B-centers (a carbon vacancy surrounded by four substituted nitrogen atoms).

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Diamond Referral Rate - SMALLS

Category		Stone Type		Fluorescence Strength		Fluorescence Colour	
Diamond	100.0%	Type I (4 stns)	66.7%	None	75.0%	Blue	0.0%
				Slight	0.0%	Red/Orange	0.0%
				Moderate	25.0%	Yellow	100.0%
				Strong	0.0%		
		Type II (2 stns)	33.3%	None	100.0%		
				Slight	0.0%		
				Moderate	0.0%		
				Strong	0.0%		

Category		Stone Type		Nitrogen Characterization Concentration (ppm)		Nitrogen Characterization Aggregation (%IaB)	
Diamond	100.0%	Type I (4 stns)	66.7%	<100	100.0%	0 - 30	100.0%
				100 - 300	0.0%	30 - 70	0.0%
				300 - 600	0.0%	>70	0.0%
				>600	0.0%		
		Type II (2 stns)	33.3%	<100	100.0%	0 - 30	100.0%
						30 - 70	0.0%
						>70	0.0%