FCC & ISED CANADA CERTIFICATION

TEST REPORT

for the

MINE SAFETY APPLIANCES (MSA) COMPANY

FCC ID: P9R-10215622

IC ID: 324C-10215622

WLL REPORT# 16598-01 REV 0

Prepared for:

Mine Safety Appliances (MSA) Company

1000 Cranberry Woods Drive

Cranberry Township, Pennsylvania 16066

Prepared By:

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4840 Winchester Boulevard

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Testing Certificate AT-1448

FCC & ISED Canada Certification Test Report

for the

Mine Safety Appliances (MSA) Company

V-TEC io1 Model:10215596

FCC ID: P9R-10215622

ISED ID: 324C-10215622

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WLL Report# 16598-01 Rev 0

Prepared by:

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Abstract

This report has been prepared on behalf of Mine Safety Appliances (MSA) Company to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.225 of the FCC Rules and Regulations and RSS 210 of Innovation, Science and Economic Development (ISED) Canada. This Certification Test Report documents the test configuration and test results for the Mine Safety Appliances (MSA) Company V-TEC io1 Model:.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 4840 Winchester Boulevard, Frederick, MD 21703. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada number is 3035A for Washington Laboratories, Ltd. Washington Laboratories, Ltd. has been accepted by the FCC, ISED and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

The Mine Safety Appliances (MSA) Company V-TEC io1 Model: complies with the limits for an intentional radiator device under FCC Part 15.225 and ISED Canada RSS 210.

Revision History	Description of Change	Date
Rev 0	Initial Release	August 7, 2020
Rev 1	Revised for ACB comments	August 24, 2020

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1 Introduction

1.1 Compliance Statement

The Mine Safety Appliances (MSA) Company V-TEC io1 Model: complies with FCC Part 15.225 (10/2010) and (ISED) Canada RSS 210 (Issue 10).

1.2 Test Scope

Tests for radiated and conducted emissions were performed. All measurements were performed in accordance with the 2014 version of ANSI C63.10. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

Test Specification	Specific Description	Result	Modifications (Y/N)
CFR47 Part 15.207, RSS Gen section 7.2.4	Class B Conducted Emissions – AC Power Ports	Pass	N
CFR47 Part 15.209, RSS Gen section 7.2.5	Class B Radiated Emissions	Pass	N
RSS Gen section 6	Receiver Spurious Emissions	Pass	N
CFR47 Part 15.225, RSS 210 section B.6	Field Strength	Pass	N
CFR47 Part 15.225, RSS GEN section 4.7	Frequency Stability	Pass	N
CFR47 Part 2.1049	Occupied Bandwidth	Pass	N

2 Equipment Under Test

2.1 EUT Identification & Description

Table 1: Device Summary

Manufacturer:	Mine Safety Appliances (MSA) Company
FCC ID:	P9R-10215622
ISED ID:	324C-10215622
Model:	V-TEC io1 Model: 10215596
Serial Number of Unit Tested	NA
FCC Rule Parts:	§15.225
ISED Rule Parts:	RSS-210
Frequency Range:	13.56 MHz
Maximum Output Power:	NA
Modulation:	GFSK
Occupied Bandwidth (99%):	72.5 kHz for all modulations
ISED Emissions Designators:	72K5F1D
Keying:	Automatic, Manual
Type of Information:	Data
Number of Channels:	1
Power Output Level	Fixed
Highest TX Spurious Emission:	1 uV/m
Highest RX Spurious Emission:	25.1 uV/m
Antenna Connector	NA
Antenna Type	PCB
Interface Cables:	NA: Charging-only USB
Power Source & Voltage:	Internal battery

The Mine Safety Appliances (MSA) Company V-TEC io1 Model: is an RFID device that detects when a safety latch on a carabiner is engaged.

2.2 Occupied Bandwidth: FCC §15.225, §2.1049

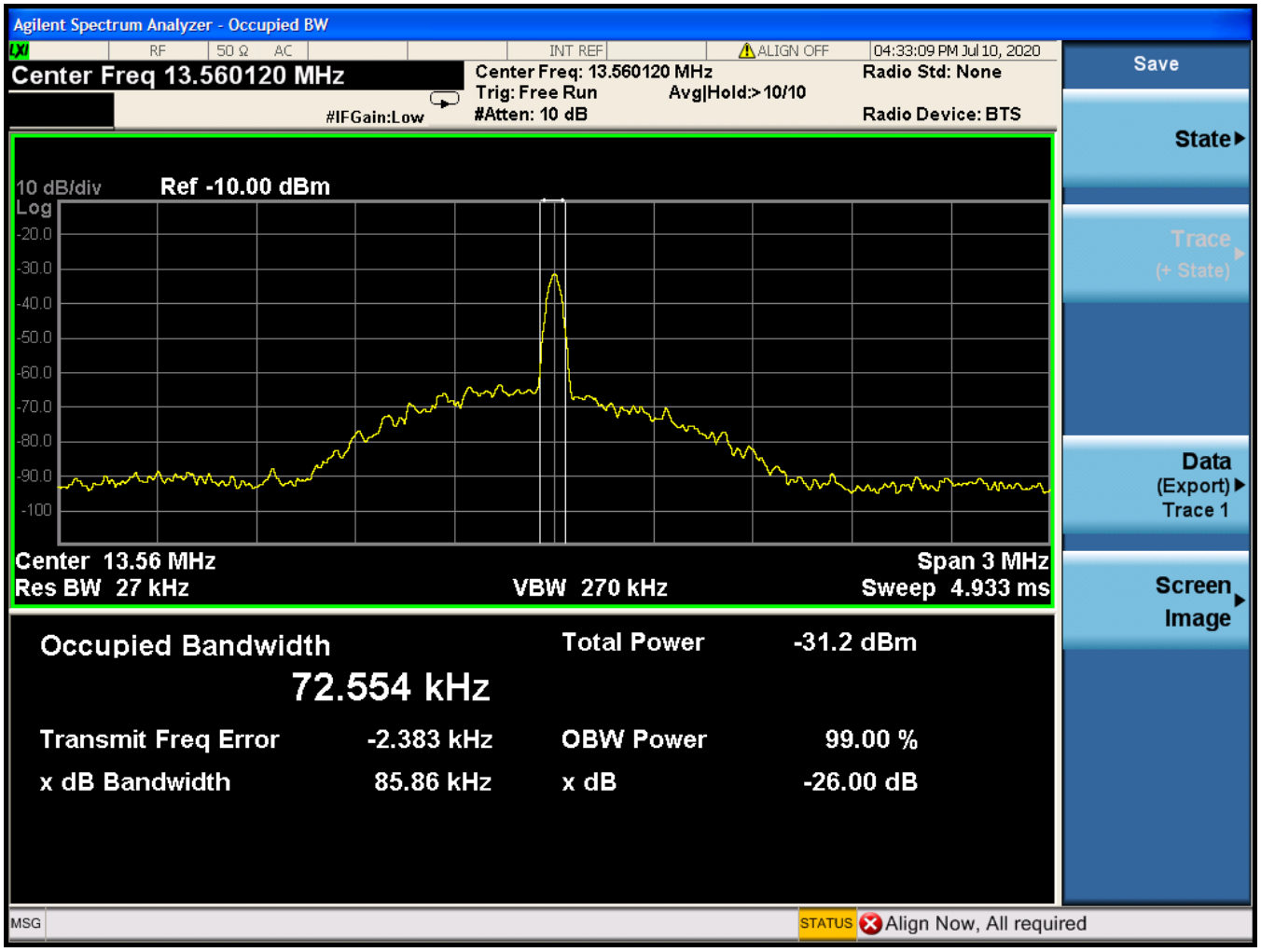
Occupied bandwidth measurement was performed by coupling the output of the EUT to the input of a spectrum analyzer using a near field probe. Table 4 provides a summary of the Occupied Bandwidth Results.

Table 2: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
13.56	72.5 kHz	N/A	N/A

The occupied bandwidth was measured as shown:

Figure 1: Occupied Bandwidth



2.3 Radiated Spurious Emissions: FCC §15.225, §15.209 & ISED RSS 210 §B.6, RSS GEN §7.2.5

Radiated emissions from the EUT must comply with the field strength limits as specified in FCC Part 15.225 and 15.209 and IC RSS 210 and RSS GEN. The limits for the radiated emissions are as shown in the following table.

Table 3: Radiated Spurious Emissions Limits

Frequency (MHz)	Limit (μV/m)	Rule Part Reference
13.553 - 13.567	15,848 (@ 30m)	§15.225(a), §RSS 210 B.6
13.410 – 13.553	334 (@ 30m)	§15.225(b), §RSS 210 B.6
13.567 – 13.710	334 (@ 30m)	§15.225(b), §RSS 210 B.6
13.110 – 13.410	106 (@ 30m)	§15.225(c), §RSS 210 B.6
13.710 – 14.010	106 (@ 30m)	§15.225(c), §RSS 210 B.6
1.705 – 13.110 14.010 – 30.0	30 (@ 30m)	§15.225(d), §RSS 210 B.6,§15.209, RSS GEN 7.2.5
30.00 – 88.00	100 (@ 3m)	§15.225(d), §RSS 210 B.6,§15.209, RSS GEN 7.2.5
88.00 – 216.00	150 (@ 3m)	§15.225(d), §RSS 210 B.6,§15.209, RSS GEN 7.2.5
216.00 – 960.00	200 (@ 3m)	§15.225(d), §RSS 210 B.6,§15.209, RSS GEN 7.2.5
Above 960	500 (@ 3m)	§15.225(d), §RSS 210 B.6,§15.209, RSS GEN 7.2.5

2.3.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on an Open Area Test Site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. For frequencies below 30MHz, the loop antenna was mounted on a tripod at a height of 1 meter and a distance of 10m from the EUT.

Above 30MHz, Biconical and log periodic broadband receiving antennas were mounted on an antenna mast to determine the height of maximum emissions. The height of the antenna was varied between 1 and 4 meters at a distance of 3 meters from the EUT. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

Below 150 kHz, bandwidths used were 300Hz RBW and 10 kHz VBW. Between 150 kHz and 30MHz, bandwidths used were 10kHz RBW and 30kHz VBW. The reading was taken at 10m. A correction factor was used to adjust the 10-meter results to the equivalent at 30 meters using the 40dB/decade roll-off. Three orientations of the loop antenna were tested.

Above 30MHz, bandwidths used were 100 kHz RBW and 30kHz VBW.

Emissions were scanned from 9 kHz to 1GHz. Emissions from were measured using a peak detector. Worst case emissions are reported in the data table.
The following is a sample calculation used in the data tables for calculating the final field strength of spurious emissions and comparing these levels to the specified limits.

Sample Calculation:

Spectrum Analyzer Voltage (SA Level):	VdBµV
Antenna Factor (Ant Corr):	AFdB/m
Cable Loss Correction (Cable Corr):	CCdB
Amplifier Gain:	GdB (if applicable)
Electric Field (Corr Level):	EdBµV/m = VdBµV + AFdB/m + CCdB - GdB
To convert to linear units:	EµV/m = antilog (EdBµV/m/20)

2.3.2 Test Results

The EUT complies with the radiated emission requirements of §15.225 and RSS-210. The following tables provide the test data.

Table 4: Radiated Emissions below 30MHz

	Frequency (MHz)	Pol H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m) @ 3m	Margin (dB)	Note
X	13.56	X	180.0	1.5	49.0	-13.6	58.8	158480	-68.6	PK
X	13.56	Y	0.0	1.5	43.0	-13.6	29.5	158480	-74.6	PK
X	13.56	Z	0.0	1.5	38.0	-13.6	16.6	158480	-79.6	PK
Y	13.56	X	180.0	1.5	43.2	-13.6	30.2	158480	-74.4	PK
Y	13.56	Y	180.0	1.5	48.5	-13.6	55.5	158480	-69.1	PK
Y	13.56	Z	0.0	1.5	41.0	-13.6	23.4	158480	-76.6	PK
Z	13.56	X	180.0	1.5	33.2	-13.6	9.5	158480	-84.4	PK
Z	13.56	Y	180.0	1.5	37.9	-13.6	16.4	158480	-79.7	PK
Z	13.56	Z	0.0	1.5	40.2	-13.6	21.3	158480	-77.4	PK
	27.12	X	0.0	0.0	15.3	-15.1	1.0	100.0	-39.8	Ambient NF
	27.12	Y	0.0	0.0	15.2	-15.1	1.0	100.0	-39.9	Ambient NF
	27.12	Z	0.0	0.0	15.1	-15.1	1.0	100.0	-40.0	Ambient NF

NF = Noise Floor

Table 5: Radiated Emissions Above 30MHz

Frequency (MHz)	Pol H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Note
40.68	V	0.0	1.0	24.0	0.0	15.8	100.0	-16.0	Ambient
54.24	V	0.0	1.0	26.0	0.0	20.0	100.0	-14.0	Ambient
67.80	V	0.0	1.0	27.0	0.0	22.4	100.0	-13.0	Ambient
81.36	V	0.0	1.0	28.0	0.0	25.1	100.0	-12.0	Ambient
122.00	V	0.0	1.0	27.7	0.0	24.3	150.0	-15.8	Ambient
40.68	H	0.0	1.0	23.9	0.0	15.7	100.0	-16.1	Ambient
54.24	H	0.0	1.0	26.1	0.0	20.2	100.0	-13.9	Ambient
67.80	H	0.0	1.0	27.0	0.0	22.4	100.0	-13.0	Ambient
81.36	H	0.0	1.0	28.0	0.0	25.1	100.0	-12.0	Ambient
122.00	H	0.0	1.0	28.1	0.0	25.4	150.0	-15.4	Ambient

*Note: Limit per FCC 15.225 (a) and RSS 210 B.6 corrected to 3 m. Restricted band radiated emissions were scanned and only noise for measurements were detected.

2.4 Conducted Emissions (AC Power Line) FCC §15.225, §15.207 & ISED RSS GEN §7.2.4

The device operates from common USB supply which is not provided by the manufacturer. An off-the-shelf AC-USB power supply was used for this testing.

Table 6: AC Power Conducted Emissions Test Data

NEUTRAL										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Corr Avg (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Mar-gin QP (dB)**	**Mar-gin AVG (dB)**
0.150	35.0	32.0	0.2	0.2	35.3	32.3	66.0	56.0	-30.7	-23.7
4.300	33.9	30.0	0.4	0.2	34.5	30.6	56.0	46.0	-21.5	-15.4
7.760	29.0	26.0	0.4	0.1	29.5	26.5	60.0	50.0	-30.5	-23.5
11.000	28.7	25.0	0.5	0.3	29.4	25.7	60.0	50.0	-30.6	-24.3
14.330	33.1	30.0	0.5	0.6	34.2	31.1	60.0	50.0	-25.8	-18.9
17.800	26.0	25.1	0.5	0.8	27.3	26.4	60.0	50.0	-32.7	-23.6

PHASE										
Frequency (MHz)	**Level QP (dBµV)**	**Level AVG (dBµV)**	**Cable Loss (dB)**	**LISN Corr (dB)**	**Level QP Corr (dBµV)**	**Level Corr Avg (dBµV)**	**Limit QP (dBµV)**	**Limit AVG (dBµV)**	**Margin QP (dB)**	**Mar gin AVG (dB)**
0.150	34.2\	30.1	0.2	0.2	110.0	30.5	66.0	56.0	44.0	-25.5
4.300	33.0	29.7	0.4	0.4	33.7	30.4	56.0	46.0	-22.3	-15.6
7.760	29.9	28.2	0.4	0.8	31.2	29.5	60.0	50.0	-28.8	-20.5
11.000	28.0	25.9	0.5	1.4	29.8	27.7	60.0	50.0	-30.2	-22.3
14.330	32.2	30.0	0.5	2.1	34.8	32.6	60.0	50.0	-25.2	-17.4
17.800	26.2	25.7	0.5	2.7	29.4	28.9	60.0	50.0	-30.6	-21.1

Transmit On, power supply BUTEFO Model JK050240-SU4US

2.5 Frequency Stability: FCC §15.225, §2.1055, & ISED RSS GEN §4.7, RSS 210 §B.6

Frequency as a function of temperature and voltage variation shall be maintained within the FCC-prescribed tolerances. Per §15.225(e) and RSS 210 B.6, the frequency tolerance shall be maintained within ±0.01% of the reference frequency.

2.5.1 Test Procedure

The temperature stability was measured with the unit in an environmental chamber used to vary the temperature of the sample. The sample was held at each temperature step to allow the temperature of the sample to stabilize.

The frequency stability of the transmitter was examined at the voltage extremes and for the temperature range of -20°C to +50°C. The carrier frequency was measured while the EUT was in the temperature chamber. The reference frequency of the EUT was measured at the ambient room temperature with the frequency counter.

The frequency stabilities can be maintained to a lesser temperature range provided that the transmitter is automatically inhibited from operating outside the lesser temperature range.

The RF carrier frequency shall not depart from the reference frequency (reference frequency is the frequency at 20ºC and rated supply voltage) in excess of +/-136 Hz.

The EUT was powered by fully-charged internal battery voltage.

Per ANSI 63.10 the EUT was tested at each temperature at the turn on point, 2-minute point, 5-minute point, and 10-minute point.

2.5.2 Test Results

The EUT complies with the temperature and voltage stability requirements of the specified standards. Test results are given in

Table 7.

Table 7: Frequency Stability Test Data vs Temperature

Temperature (C)	**Frequency (MHz)**	**Deviation (Hz)**	**Limit (+/- Hz)**	**Pass/Fail**
22(ambient)	13.560117	0	136	**NA**
-30	13.560057	-60	136	Pass
-20	13.560115	-2	136	Pass
-10	13.560154	37	136	Pass
0	13.560137	20	136	Pass
10	13.560117	0	136	Pass
20	13.560114	-3	136	Pass
30	13.560117	0	136	Pass
40	13.560114	-3	136	Pass
50	13.560094	-23	136	Pass

Fully-charged battery is 4.2VDC. At 3.5VDC, battery-low warnings are emitted. The battery end-point is 2.9VDC.

Table 8: Frequency Stability Test Data vs Voltage

Voltage		**Frequency (MHz)**	**Deviation (Hz)**	**Limit (+/-Hz)**	**Pass/Fail**
4.2	Fully-charged	13.560117	0	136	**NA**
3.5	Battery warning	13.560117	0	136	Pass
2.9	Battery end	13.560119	2	136	Pass

2.6 Contract Information

Customer:	Mine Safety Appliances (MSA) Company
Purchase Order Number:	4502747716
Quotation Number:	72131

2.7 Test and Support Personnel

Washington Laboratories, LTD	Mike Violette
Customer Representative	David Kodrin

2.8 Test Configuration

The V-TEC io1 Model: was configured to continuously transmit. No other devices were used during the testing.

2.9 Interface Cables

NONE

2.10 Testing Algorithm

The V-TEC io1 Model: was continuously transmitting.

2.11 Test Location

All measurements herein were performed at Washington Laboratories, Ltd. test center in Frederick, MD. Site description and site attenuation data have been placed on file with the FCC's Sampling and Measurements Branch at the FCC laboratory in Columbia, MD. The ISED Canada number is 3035A for Washington Laboratories, Ltd. Washington Laboratories, Ltd. has been accepted by the FCC, ISED and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.12 Measurements

2.12.1 References

ANSI C63.2 (Jan-2016) Specifications for Electromagnetic Noise and Field Strength Instrumentation
ANSI C63.4 (Jan 2014) American National Standard for Methods of Measurement of Radio-Noise Emissions from Low-Voltage Electrical and Electronic Equipment in the Range of 9 kHz to 40 GHz
ANSI C63.10 (Jun 2013) American National Standard of Procedures for Compliance Testing of Unlicensed Wireless Devices

2.13 Measurement Uncertainty

All results reported herein relate only to the equipment tested. The basis for uncertainty calculation uses ANSI/NCSL Z540-2-1997 (R2002) with a type B evaluation of the standard uncertainty. Elements contributing to the standard uncertainty are combined using the method described in Equation 1 to arrive at the total standard uncertainty. The standard uncertainty is multiplied by the coverage factor to determine the expanded uncertainty which is generally accepted for use in commercial, industrial, and regulatory applications and when health and safety are concerned (see Equation 2). A coverage factor was selected to yield a 95% confidence in the uncertainty estimation.

Equation 1: Standard Uncertainty

$$u_c = \pm\sqrt{\frac{a^2}{div_a^2} + \frac{b^2}{div_b^2} + \frac{c^2}{div_c^2} + ...}$$

Where uc = standard uncertainty
a, b, c,.. = individual uncertainty elements
Diva, b, c = the individual uncertainty element divisor based on the probability distribution
Divisor = 1.732 for rectangular distribution
Divisor = 2 for normal distribution
Divisor = 1.414 for trapezoid distribution

Equation 2: Expanded Uncertainty

$$U = k u_c$$

Where:
U = expanded uncertainty
k = coverage factor
k ≤ 2 for 95% coverage (ANSI/NCSL Z540-2 Annex G)
uc = standard uncertainty

The measurement uncertainty complies with the maximum allowed uncertainty from CISPR 16-4-2. Measurement uncertainty is not used to adjust the measurements to determine compliance. The expanded uncertainty values for the various scopes in the WLL accreditation are provided in Table 9 below.

Table 9: Expanded Uncertainty List

Scope	Standard(s)	Expanded Uncertainty
Conducted Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±2.63 dB
Radiated Emissions	CISPR11, CISPR22, CISPR32, CISPR14, FCC Part 15	±4.55 dB

3 Test Equipment

Table 10 shows a list of the test equipment used for measurements along with the calibration information.

Table 10: Test Equipment List

Test Name:	**Conducted Emissions Voltage**	Test Date:	**07/08/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00528	AGILENT	E4446A	1/21/2021
Test Name:	**Radiated Emissions**	Test Date:	**07/08/2020**
Asset #	**Manufacturer/Model**	**Description**	**Cal. Due**
00382	SUNOL SCIENCES CORPORATION	JB1	8/1/2020
00065	HP	8447D	6/19/2021
00528	AGILENT	E4446A	1/21/2021
00031	EMCO	6502	8/1/2020
00776	TENNEY	TJR-A-WS4	4/28/2021
00823	AGILENT	N9010A	5/7/2021