

Washington Laboratories, Ltd.

FCC PART 15.231 CERTIFICATION TEST REPORT

for the

WTC TX

FCC ID: YJ7WTCTX

IC ID: 9082A-WTCTX

REPORT# 15853 -01 REV 2

Prepared for:

Stanley Black & Decker, Inc.

701 E. Joppa Road - TW116

Towson, MD 21286

Prepared By:

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7560 Lindbergh Drive

Gaithersburg, Maryland 20879





FCC Part 15.231 Certification Test Report
for the
Stanley Black & Decker, Inc.
WTC TX

FCC ID: YJ7WTCTX
ISED ID: 9082A-WTCTX

DECEMBER 21, 2018

WLL REPORT# 15853 -01 REV 2

Prepared by:

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Reviewed by:

Steven D. Koster
President



ABSTRACT

This report has been prepared on behalf of Stanley Black & Decker, Inc. to support the attached Application for Equipment Authorization. The test report and application are submitted for an Intentional Radiator under Part 15.231 of the FCC Rules and Regulations and Spectrum Management and Telecommunications Policy RSS-210 of Innovation, Science and Economic Development Canada. This Certification Test Report documents the test configuration and test results for the Stanley Black & Decker, Inc. WTC TX.

Testing was performed on an Open Area Test Site (OATS) of Washington Laboratories, Ltd, 7560 Lindbergh Drive, Gaithersburg, MD 20879. 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 OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively.

Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Certificate AT-1448 as an independent FCC test laboratory.

The Stanley Black & Decker, Inc. WTC TX complies with the limits for an Intentional Radiator device under FCC Part 15.231(a) and RSS-210 of Innovation, Science and Economic Development Canada (ISED).

Revision History	Description of Change	Date
Rev 0	Initial Release	DECEMBER 21, 2018
Rev 2	Changes per Customer Request	JANUARY 17, 2019
Rev 2	Changes per ACB comments	JANUARY 28, 2019



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1 INTRODUCTION

1.1 COMPLIANCE STATEMENT

The Stanley Black & Decker, Inc. WTC TX complies with the limits for an Intentional Radiator device under FCC Part 15.231 and ISSED Canada RSS-210.

TX Test Summary (Low Power Transmitter)			
FCC Rule Part	IC Rule Part	Description	Result
15.231 (a)	RSS-210	Transmission Length	Pass
15.231 (b)	RSS-210	Field Strength Limits	Pass
15.231 (c)	RSS-210	20dB Bandwidth	Pass
15.207	RSS-Gen [7.2.2]	AC Conducted Emissions	NA – Battery Powered Device
RX/Digital Test Summary (Low Power Transmitter)			
FCC Rule Part	IC Rule Part	Description	Result
15.107	RSS-Gen [7.2.2]	AC Conducted Emissions	NA – Battery Powered Device
15.109	RSS-Gen [7.2.3.2]	General Field Strength Limits (Restricted Bands & RE Limits)	Pass

1.2 TEST SCOPE

Tests for radiated emissions were performed. The measurement equipment conforms to ANSI C63.2 Specifications for Electromagnetic Noise and Field Strength Instrumentation.

1.3 CONTRACT INFORMATION

Customer: Stanley Black & Decker, Inc.
Address 701 E. Joppa Road - TW116
Towson, MD 21286



Purchase Order Number: 229689

Quotation Number: 71130

1.4 TEST DATES

Testing was performed on the following date(s): 12/17/2019

1.5 TEST AND SUPPORT PERSONNEL

Washington Laboratories, LTD	Nikolas Allen
Customer Representative	Kirwan Magdamo



1.6 ABBREVIATIONS

A	Ampere
ac	alternating current
AM	Amplitude Modulation
Amps	Amperes
b/s	bits per second
BW	BandWidth
CE	Conducted Emission
cm	Centimeter
CW	Continuous Wave
dB	deciBel
dc	direct current
EMI	Electromagnetic Interference
EUT	Equipment Under Test
FM	Frequency Modulation
G	giga – prefix for 10^9 multiplier
Hz	Hertz
IF	Intermediate Frequency
k	kilo – prefix for 10^3 multiplier
LISN	Line Impedance Stabilization Network
M	Mega – prefix for 10^6 multiplier
m	Meter
μ	micro – prefix for 10^{-6} multiplier
NB	Narrowband
QP	Quasi-Peak
RE	Radiated Emissions
RF	Radio Frequency
rms	root-mean-square
SN	Serial Number
S/A	Spectrum Analyzer
V	Volt



2 EQUIPMENT UNDER TEST

2.1 EUT IDENTIFICATION & DESCRIPTION

Table 1: Device Summary

Item	Wireless transmitter embedded in various power tools that pulses to a receiving module to signal operation of the transmitting tool.
Manufacturer:	Stanley Black & Decker, Inc.
FCC ID:	YJ7WTCTX
ISED ID:	9082A-WTCTX
Model:	WTC TX
FCC Rule Parts:	§15.231
ISED Rule Parts:	RSS-210
Frequency Range:	433.9 MHz
Maximum Output Power:	9742.3 uV/m
Modulation:	Single Pulse
Occupied Bandwidth (20dB):	92.75 kHz for all modulations
FCC Emission Designator:	92K7P0N
ISED Emissions Designators:	92K7P0N
Keying:	Automatic, Manual
Type of Information:	Pulse
Number of Channels:	1
Power Output Level	Fixed
Highest TX Spurious Emission:	176.4 uV/m
Antenna Connector	Internal
Antenna Type	PCB Antenna
Interface Cables:	None
Maximum Data Rate	NA
Power Source & Voltage:	5 - 25 Volts



The Stanley Black & Decker, Inc. WTC TX is a Wireless module embedded in various power tools to transmit a periodic 433.9 MHz signal to a receiving module to remotely signal operation of the transmitting tool.

2.2 TEST CONFIGURATION

The WTC TX was configured in a stand-alone configuration.

2.3 TESTING ALGORITHM

The WTC TX was tested was tested in a continuous transmit operation.

2.4 TEST LOCATION

All measurements herein were performed at Washington Laboratories, Ltd. test center in Gaithersburg, 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 OATS numbers are 3035A-1 and 3035A-2 for Washington Laboratories, Ltd. Site 1 and Site 2, respectively. Washington Laboratories, Ltd. has been accepted by the FCC and approved by ANAB under Testing Certificate AT-1448 as an independent FCC test laboratory.

2.5 MEASUREMENTS

2.5.1 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



2.6 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

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

Where u_c = standard uncertainty

$a, b, c, \dots$ = individual uncertainty elements

$Div_{a, b, c}$ = 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

$$U = ku_c$$

Where U = expanded uncertainty

k = coverage factor

$k \leq 2$ for 95% coverage (ANSI/NCSL Z540-2 Annex G)

u_c = 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 2 below.



Table 2: 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 3 shows a list of the test equipment used for measurements along with the calibration information.

Table 3: Test Equipment List

Test Name:	Conducted Emissions Voltage	Test Date:	12/18/2018
Asset #	Manufacturer/Model	Description	Cal. Due
125	SOLAR - 8028-50-TS-24-BNC	LISN	5/23/2019
126	SOLAR - 8028-50-TS-24-BNC	LISN	5/23/2019
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	4/21/2019
Test Name:	Radiated Emissions	Test Date:	12/19/2018
Asset #	Manufacturer/Model	Description	Cal. Due
4	ARA - DRG-118/A	ANTENNA DRG 1-18GHZ	12/31/2018
644	SUNOL SCIENCES CORPORATION - JB1 925-833- 9936	BICONALOG ANTENNA	1/16/2020
823	AGILENT - N9010A	EXA SPECTRUM ANALYZER	4/21/2019
559	HP - 8447D	AMPLIFIER	2/12/2019
627	AGILENT - 8449B	AMPLIFIER 1-26GHZ	2/12/2019



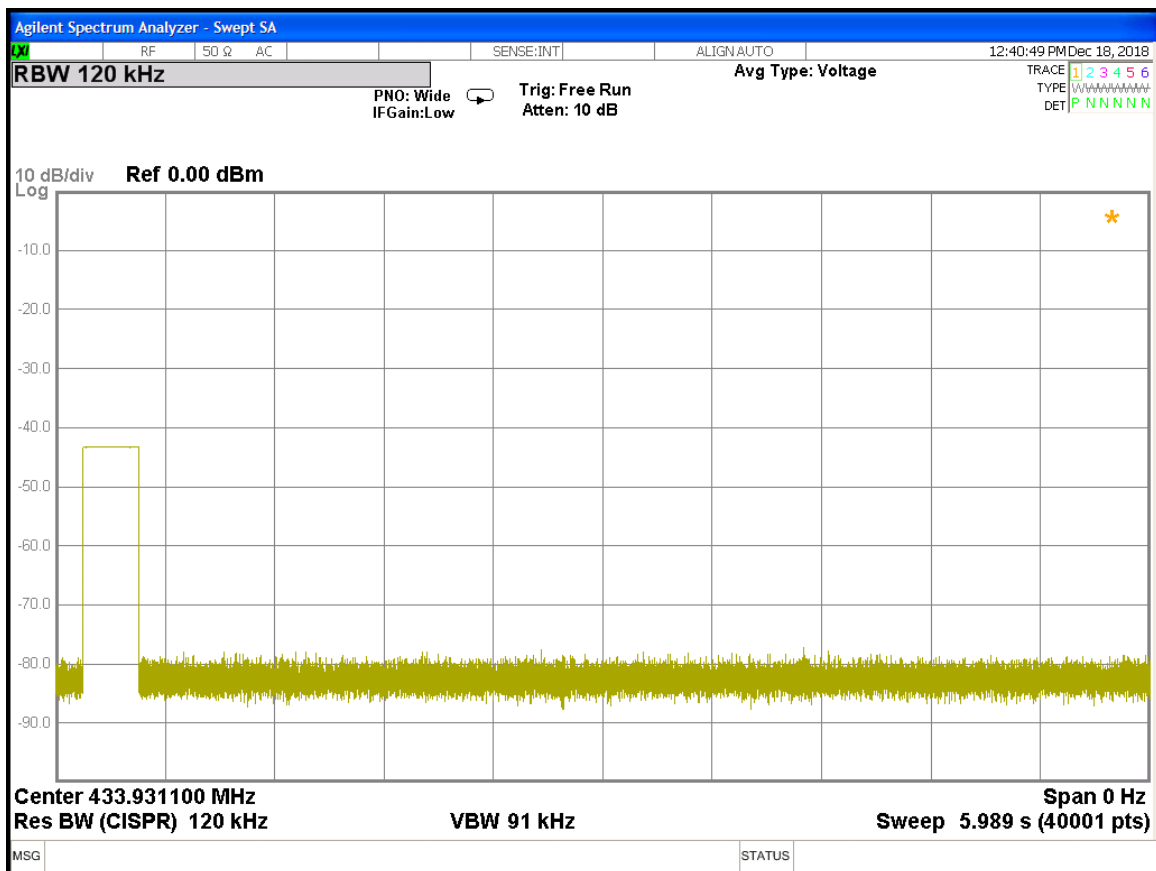
4 TEST RESULTS

4.1 TRANSMISSION CESSATION FROM TIME OF RELEASE (FCC PART §15.231(A), RSS210 A1.2 AND RSS GEN 6.13)

FCC Part 15.231 states that a periodic intentional radiator shall cease transmission within a five second period from release of automatic or manual keying of operation.

Testing was done to verify that the WTC TX stopped transmitting within the required time period. A 6 second sweep was made, during which the control toggle was activated and released, and the time to transmission end was measured. Figure 1 shows the indicated time period from un-keying the device until cessation of transmission. The EUT complies with the requirements for this section.

Figure 1: Time Period: Release to Termination of Transmission





4.2 OCCUPIED BANDWIDTH (FCC PART §2.1049 AND RSS-GEN 6.7):

Occupied bandwidth was performed by coupling the output of the EUT to the input of a spectrum analyzer.
No Limits are provided for this measurement

Table 4: Occupied Bandwidth Spectrum Analyzer Settings

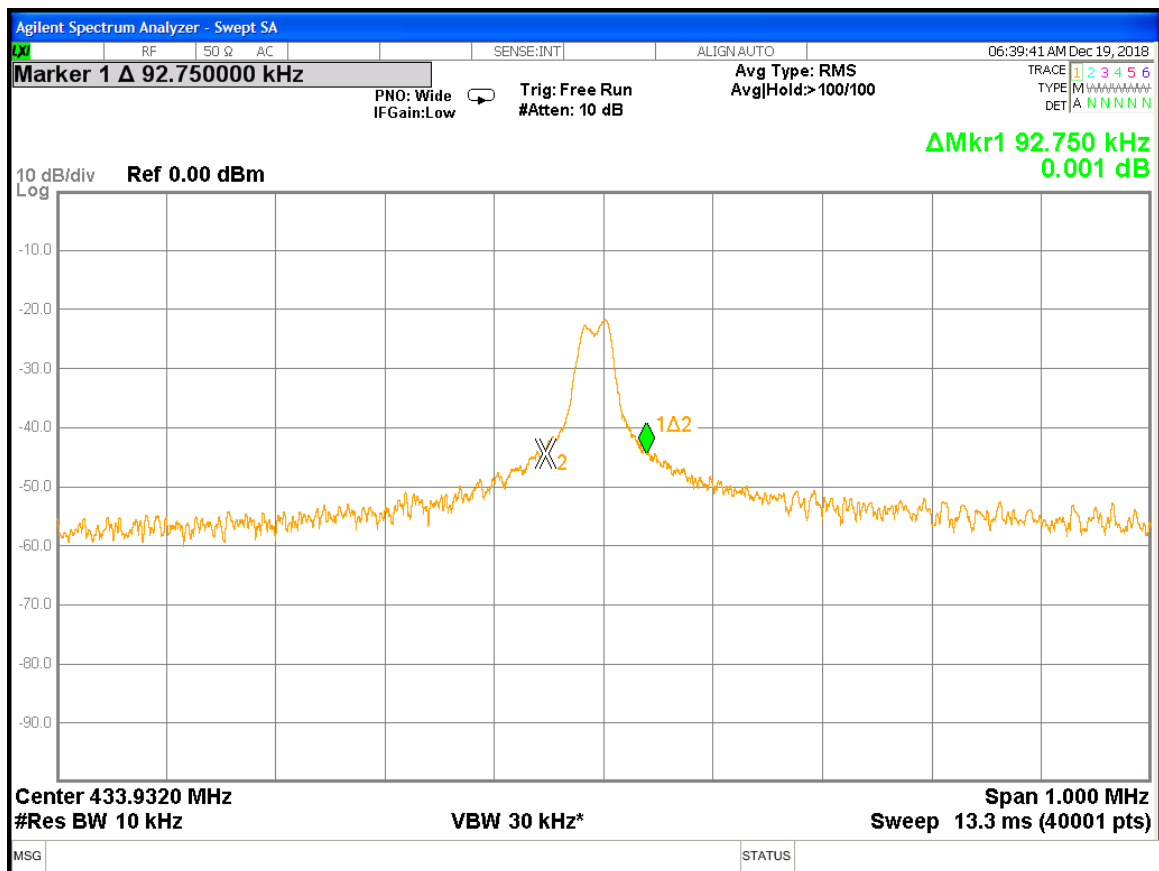
Resolution Bandwidth	Video Bandwidth
10 kHz	30 kHz

At full modulation, the occupied bandwidth was measured as shown:

Table 5 provides a summary of the Occupied Bandwidth Results.

Table 5: Occupied Bandwidth Results

Frequency	Bandwidth	Limit	Pass/Fail
433.9 MHz	92.75 kHz	1.08 MHz	Pass





4.3 RADIATED EMISSIONS: (FCC PART §15.231(A), RSS210 A1.2)

4.3.1 Test Procedure

The EUT was placed on motorized turntable for radiated testing on a 3-meter open field test site. The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. 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. The peripherals were placed on the table in accordance with ANSI C63.4-2014. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

All three axes were investigated for maximum emissions.

The emissions were measured using the following resolution bandwidths:

Table 6: Spectrum Analyzer Settings

Frequency Range	Resolution Bandwidth	Video Bandwidth
30MHz-1000 MHz	120kHz	>100 kHz
>1000 MHz	1 MHz	10 Hz (Avg.), 1MHz (Peak)

Average measurements above 1GHz were made with the Spectrum analyzer set to the linear mode with a Video bandwidth of 10Hz, and the resultant reading mathematically converted to dBuV. Correction factors were then applied and the resulting value was compared to the limit.



Table 7: Radiated Emission Test Data, Transmitter

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
433.94	V	270.00	1.20	83.94	-5.2	8672.8	10958.2	-2.0	Fundamental
433.94	H	270.00	1.00	84.95	-5.2	9742.3	10958.2	-1.0	Fundamental
1301.73	V	180.00	1.00	43.16	-7.8	58.9	5000.0	-38.6	PEAK
1301.73	V	180.00	1.00	36.08	-7.8	26.1	500.0	-25.7	AVERAGE
1735.69	V	90.00	1.16	51.04	-6.1	176.4	5000.0	-29.1	PEAK
1735.69	V	90.00	1.16	44.71	-6.1	85.1	500.0	-15.4	AVERAGE
								-	
1301.67	H	270.00	1.00	42.44	-7.8	54.2	5000.0	-39.3	PEAK
1301.67	H	270.00	1.00	34.82	-7.8	22.6	500.0	-26.9	AVERAGE
1735.75	H	270.00	1.00	46.67	-6.1	106.7	5000.0	-33.4	PEAK
1735.75	H	270.00	1.00	42.27	-6.1	64.3	500.0	-17.8	AVERAGE

Radiated emissions were tested from 30 MHz to 4334 MHz.

4.4 RADIATED EMISSIONS

4.4.1 Requirements

Compliance Standard: FCC Part 15, Class B



Spurious FCC Compliance Limits		
Frequency Range	Limit (distance)	
	Class A (10 meter)	Class B (3 meter)
30-88 MHz	90 $\mu\text{V/m}$	100 $\mu\text{V/m}$
88-216 MHz	150 $\mu\text{V/m}$	150 $\mu\text{V/m}$
216-960 MHz	210 $\mu\text{V/m}$	200 $\mu\text{V/m}$
>960MHz	300 $\mu\text{V/m}$	500 $\mu\text{V/m}$

4.4.2 Test Procedure

The requirements of FCC Part 15 and ICES-003 call for the EUT to be placed on an 80 cm high 1 X 1.5 meters non-conductive motorized turntable for radiated testing on a 3-meter open field test site.

The emissions from the EUT were measured continuously at every azimuth by rotating the turntable. Bi-conical and log periodic broadband 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. The output of the antenna was connected to the input of the spectrum analyzer and the emissions in the frequency range of 30 MHz to 5 GHz were measured. The peripherals were placed on the table in accordance with ANSI C63.4. Cables were varied in position to produce maximum emissions. Both the horizontal and vertical field components were measured.

The output from the antenna was connected, via a preamplifier, to the input of the spectrum analyzer. The detector function was set to quasi-peak or peak, as appropriate. Above 1GHz average measurement are recorded. The measurement bandwidth of the spectrum analyzer system was set to at least 120 kHz, with all post-detector filtering no less than 10 times the measurement bandwidth. Frequencies above 1GHz were performed using a measurement bandwidth of 1MHz with a video bandwidth setting of 10 Hz for the average measurement.



4.4.3 Radiated Data Reduction and Reporting

To convert the raw spectrum analyzer radiated data into a form that can be compared with the FCC limits, it is necessary to account for various calibration factors that are supplied with the antennas and other measurement accessories. These factors are included into the antenna factor (AF) column of the table and in the cable factor (CF) column of the table. The AF (in dB/m) and the CF (in dB) is algebraically added to the raw Spectrum Analyzer Voltage in dB μ V to obtain the Radiated Electric Field in dB μ V/m. This logarithm amplitude is converted to a linear amplitude, then compared to the FCC limit.

Example:

Spectrum Analyzer Voltage: VdB μ V

Antenna Correction Factor: AFdB/m

Cable Correction Factor: CFdB

Pre-Amplifier Gain (if applicable): GdB

Electric Field: EdB μ V/m = V dB μ V + AFdB/m + CFdB - GdB

To convert to linear units of measure: EdB μ V/m/20 Inv log

4.4.4 Test Data

The EUT complied with the Class B Radiated Emissions requirements. Table 8 provides the test results for radiated emissions.



Table 8: Radiated Emission Test Data

Frequency (MHz)	Polarity H/V	Azimuth (Degree)	Ant. Height (m)	SA Level (dBuV)	Corr Factors (dB)	Corr. Level (uV/m)	Limit (uV/m)	Margin (dB)	Comments
66.35	V	90.00	1.10	52.02	-14.9	71.9	100.0	-2.9	Peak
66.35	V	90.00	1.10	45.19	-14.9	32.7	100.0	-9.7	QP
74.03	V	90.00	1.00	48.07	-14.5	47.6	100.0	-6.5	Peak
74.03	V	90.00	1.00	40.02	-14.5	18.8	100.0	-14.5	QP
110.61	V	90.00	1.00	40.05	-9.8	32.5	150.0	-13.3	Peak
110.61	V	90.00	1.00	36.02	-9.8	20.4	150.0	-17.3	QP
238.39	V	180.00	1.21	41.52	-9.9	38.3	200.0	-14.4	Peak
238.39	V	180.00	1.21	35.84	-9.9	19.9	200.0	-20.0	QP
305.14	V	270.00	1.21	37.41	-7.7	30.7	200.0	-16.3	Peak
305.14	V	270.00	1.21	32.71	-7.7	17.9	200.0	-21.0	QP
326.62	V	270.00	1.30	44.74	-6.9	77.7	200.0	-8.2	Peak
326.62	V	270.00	1.30	42.78	-6.9	62.0	200.0	-10.2	QP
345.42	V	270.00	1.10	40.68	-6.4	51.7	200.0	-11.8	Peak
345.42	V	270.00	1.10	38.03	-6.4	38.1	200.0	-14.4	QP
66.35	H	90.00	1.01	52.78	-14.9	78.5	100.0	-2.1	Peak
66.35	H	90.00	1.01	43.78	-14.9	27.8	100.0	-11.1	QP
74.12	H	91.00	1.00	53.81	-14.5	92.1	100.0	-0.7	Peak
74.12	H	91.00	1.00	43.29	-14.5	27.4	100.0	-11.2	QP
238.39	H	270.00	1.79	39.82	-9.9	31.5	200.0	-16.1	Peak
238.39	H	270.00	1.79	36.11	-9.9	20.5	200.0	-19.8	QP
305.14	H	0.00	1.00	39.81	-7.7	40.5	200.0	-13.9	Peak
305.14	H	0.00	1.00	36.13	-7.7	26.5	200.0	-17.5	QP
325.44	H	0.00	1.00	41.93	-6.9	56.2	200.0	-11.0	Peak
325.44	H	0.00	1.00	40.02	-6.9	45.1	200.0	-12.9	QP
326.59	H	0.00	1.00	38.54	-6.9	38.0	200.0	-14.4	Peak
326.59	H	0.00	1.00	35.37	-6.9	26.4	200.0	-17.6	QP
343.81	H	270.00	1.00	43.04	-6.4	67.6	200.0	-9.4	Peak
343.81	H	270.00	1.00	40.85	-6.4	52.5	200.0	-11.6	QP