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Global Product Certification
EMC-EMF Safety Approvals

EMI TEST REPORT
for
CERTIFICATION of
FCC PART 15.225 & FCC PART 15.207 TRANSMITTER

FCC ID:	2ACXQ-MDR-3021AT
Manufacturer:	Sato Vicinity Pty Ltd
Test Sample:	RFID read-write reader
Model Number:	MDR-3021AT
Serial Number:	Production Prototype
Date:	8th September 2014

Accreditation No. 5292

Accredited for compliance with ISO/IEC 17025. The results of tests, calibration and/or measurements included in this document are traceable to Australian/national standards. NATA is a signatory to the ILAC Mutual Recognition Arrangement for the mutual recognition of the equivalence of testing and calibration reports.

EMI TEST REPORT FOR CERTIFICATION
FOR
CERTIFICATION OF FCC Part 15.225 & FCC PART 15.207 TRANSMITTER

FCC ID: 2ACXQ-MDR-3021AT

EMC Technologies Report No. T140704_F

Date: 8th September 2014

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Report Number:	T140704_F
Test Sample Name:	RFID read-write reader
Model Number:	MDR-3021AT
Serial Number:	Production Prototype
FCC ID:	2ACXQ-MDR-3021AT
Manufacturer:	Sato Vicinity Pty Ltd
Tested For:	Sato Vicinity Pty Ltd
Address:	8 Guihen Street, Annandale, NSW, 2038
Phone Number:	(02) 9562 9800
Fax Number:	(02) 9518 7620
Responsible Party:	Mr Tai Wai Pong
Test Standards:	**FCC Part 15.225 Intentional Radiators** **FCC Part 15.207 Conducted Limits** **ANSI C63.4:2009**
Test Dates:	5th August 2014 to 11th August 2014
Testing Officers:	**Joel Mulig** **Jason Cameron**
Attestation:	*I hereby certify that the device(s) described herein were tested as described in this report and that the data included is that which was obtained during such testing.*
Authorised Signature:	**Christian Kai** **Facility Manager** **EMC Technologies Pty Ltd**

Issued by EMC Technologies Pty Ltd, Unit 3/87 Station Road, Seven Hills, NSW, 2147, Australia.
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EMI TEST REPORT FOR CERTIFICATION of FCC PART 15.225 & FCC PART 15.207 TRANSMITTER on the RFID read-write reader

1.0 SUMMARY of RESULTS

This report details the results of EMI tests and measurements performed on the RFID read-write reader with Model Number: MDR-301AT, in accordance with the Federal Communications Commission (FCC) regulations as detailed in Title 47 CFR, Part 15 Rules for intentional radiators. All results are detailed in this report.

Part 15.31e
Amplitude stability with supply variation: Complied

Part 15.207
Conducted Emissions: Complied

Part 15.225a, b & c
Carrier Signal Field Strength 13.110 – 14.010MHz: Complied

Part 15.225d (15.209)
Field Strength Outside 13.110 – 14.010MHz: Complied

Part 15.225 e
Frequency Tolerance: Complied

1.1 EUT – Voltage Power Conditions

Testing was performed at a voltage of 120V, 60Hz.

2.0 GENERAL INFORMATION

2.1 General Description of Test Sample

Manufacturer	:	Sato Vicinity Pty Ltd
Test Sample	:	RFID read-write reader
Model Number	:	MDR-3021AT
Serial Number	:	Production Prototype
Part Number	:	079-70-003
FCC ID	:	2ACXQ-MDR-3021AT
Equipment Type	:	Intentional Radiator

2.2 Test Sample Description

The EUT is a RFID read-write reader.

2.3 Technical Specifications and System Overview

Crystal Frequency	:	50MHz, 27.12MHz, 18.432MHz
Highest operating Freq	:	50MHz
Microprocessor	:	AT91rm9200
Input Power Supply	:	100-240V, 1.5A, 50-60Hz

2.4 EUT Configurations

The EUT is to be tested as a tabletop unit with the antenna terminated and antenna connected.

2.5 Test Sample Support Equipment

There was no support equipment.

2.6 Test Sample Block Diagram

Refer to Appendix E for Test Sample Block Diagram.

2.7 EUT Operation Conditions

Refer to Appendix J for Operational Description.

2.8 Modifications

No modifications were performed on the EUT in order to comply with the standards.

2.9 Test Procedure

Radiated Emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009. The measurement distance for radiated emissions was 3 metres from the EUT for the frequency range 9kHz-1000MHz.

2.10 Test Facility

2.10.1 General

Conducted Emission measurements of fundamental frequency 13.56 MHz were performed at EMC Technologies Laboratory in Seven Hills, New South Wales, Australia. Radiated Emission measurements in the ranges 9kHz-1000MHz were performed at EMC Technologies' indoor open area test site (iOATS) situated at Seven Hills, NSW, Australia.

The above sites have been fully described in a report submitted to the FCC office.
EMC Technologies Pty Ltd has FCC registration number 411703 and we have been designated by the Australian Communications and Media Authority under the APAC TELMRA and our designation number is AU0002 which will expire on the 7th August 2016.

2.10.2 NATA Accreditation

EMC Technologies is accredited in Australia to test to the following standards by the National Association of Testing Authorities (NATA).

"FCC Part 15 unintentional and intentional emitters in the frequency range 9kHz to 18GHz excluding TV receivers (15.117 and 15.119), TV interface devices (15.115), cable ready consumer electronic equipment (15.118), cable locating equipment (15.213) and unlicensed national information infrastructure devices (Sub part E)."

The current full scope of accreditation can be found on the NATA website:
www.nata.asn.au
It also includes a large number of emission, immunity, SAR, EMR and Safety standards.

NATA is the Australian national laboratory accreditation body and has accredited EMC Technologies to operate to the IEC/ISO17025 requirements. A major requirement for accreditation is the assessment of the company and its personnel as being technically competent in testing to the standards. This requires fully documented test procedures, continued calibration of all equipment to the National Standard at the National Measurements Institute (NMI) and an internal quality system to ISO 9002. NATA has mutual recognition agreements with the National Voluntary Laboratory Accreditation Program (NVLAP) and the American Association for Laboratory Accreditation (A^2LA).

2.11 Units of Measurements

2.11.1 Conducted Emissions

Measurements are reported in units of dB relative to one microvolt (dBμV).

2.11.2 Radiated Emissions

Measurements are reported in units of dB relative to one microvolt per metre (dBμV/m). The measurement distance was 3 metres from the EUT for ranges 9kHz -1000MHz.

2.12 Test Equipment Calibration

All measurement instrumentation and transducers were calibrated in accordance with the applicable standards by an independent NATA registered laboratory such as Agilent Technologies (Australia) Pty Ltd or the National Measurement Institute (NMI). All equipment calibration is traceable to Australia national standards at the National Measurement Institute. The reference antenna calibration was performed by NMI and the working antennas (biconical and log-periodic) calibrated by the NATA approved procedures. The complete list of test equipment used for the measurements, including calibration dates and traceability is contained in Appendix A of this report.

3.0 CONDUCTED EMISSION MEASUREMENTS

3.1 Test Procedure

The arrangement specified in ANSI C63.4:2009 was adhered to for the conducted EMI measurements. The EUT was placed in the RF screened enclosure and a CISPR EMI Receiver as defined in ANSI C63.2-2009 was used to perform the measurements.

The EMI Receiver was operated under program control using the Max-Hold function and automatic frequency scanning, measurement and data logging techniques. The specified 0.15 MHz to 30 MHz frequency range was sub-divided into sub-ranges to ensure that all duration peaks were captured.

3.2 Peak Maximizing Procedure

For each of the sub-ranges, the EMI receiver was set to continuous scan with the Peak detector set to Max-Hold mode. The Quasi-Peak detector was then invoked to measure the actual Quasi-Peak level of the most significant peaks which were detected.

The highest recorded EMI signals are shown on the Peaks List on the bottom right side of the graph. Peaks that were greater than 20dB below the limit were not measured. For each numbered peak the frequency, peak field strength, Quasi-peak field strength, Average field strength and the margin relative to the limit in dB is listed. A negative margin is the level below the limit.

3.3 Calculation of Voltage Levels

The voltage levels were automatically measured in software and compared to the test limit. The method of calculation was as follows:

$V_{EMI} = V_{Rx} + L_{BPF}$

Where:

V_{EMI} = The Measured EMI voltage in dBµV to be compared to the limit.
V_{Rx} = The Voltage in dBµV read directly at the EMI receiver.
L_{BPF} = The insertion loss in dB of the cables and the Limiter and Pass Filter.

3.4 Plotting of Conducted Emission Measurement Data

The measurement data pertaining to each frequency sub-range were then concatenated to form a single graph of (peak) amplitude versus frequency. This was performed for both Active and Neutral lines and the composite graph was subsequently plotted. A list of the highest relevant peaks and the respective Quasi-Peak and Average values were also plotted on the graphs.

3.5 Conducted EMI Results

3.5.1 Tested with Antenna Connected

Frequency MHz	Line	Measured QP Value dBµV	QP Limit dBµV	Δ QP ±dB	Measured Av. Value dBµV	AV Limit dBµV	ΔAV ±dB
13.56	Active	73.2	60.0	+13.2	73.0	50.0	+23.0
13.56	Active	72.6	60.0	+12.6	72.0	50.0	+22.0

Only the intentional transmit frequency exceeded the conducted emissions limit. All other frequencies measured more than 10dB below the limit.

Refer to Appendix H, Graphs 1 and 2.

3.5.2 Tested with Antenna Terminated

Frequency MHz	Line	Measured QP Value dBµV	QP Limit dBµV	Δ QP ±dB	Measured Av. Value dBµV	AV Limit dBµV	ΔAV ±dB
13.56	Active	49.8	60.0	-10.2	43.5	50.0	-6.5

The highest emission was at 13.56MHz on the Active line, which was measured at greater than 10dB below the Quasi-peak limit and at least 6.5dB below the Average limit.

Refer to Appendix H, Graphs 3 and 4.

3.6 Results of Conducted Emission Measurement

The EUT complied with the limits of FCC Rule Part 15 Subpart C – Intentional Radiators. Emissions.

4.0 RADIATED EMISSION MEASUREMENTS – 9kHz to 1000MHz

4.1 Frequency Range of Radiated Measurements

The highest frequency of the EUT is 50 MHz (refer to section 2.3 of this report).

Highest frequency generated or used in the device or on which the device operates or tunes [MHz]	Upper frequency of measurement range [MHz]
1.705 - 108	1000
108 – 500	2000
500 – 1000	5000
Above 1000	10^{th} harmonic of the highest frequency or 40 GHz, whichever is lower

Frequencies above 1 GHz: Average trace taken

According to the table in FCC Part 15, Section 15.33 and the highest radio frequency signal generated or used in the EUT is 50MHz, the radiated emissions measurement were performed from 9kHz to 1000MHz.

4.2 Test Procedure

Radiated emissions measurements were performed in accordance with the procedures of ANSI C63.4:2009 Radiated emission tests from 9kHz to 1000MHz were performed at the indoor Open Area Test Site (iOATS) an EUT distance of 3 metres. OET Bulletin 65 was used for reference.

The EUT was placed on a styrofoam table, 0.8m above the ground plane and operated in accordance with section 2 of this report. The EMI Receiver was operated under software control via the PC Controller.

4.2.1 0.009 to 30 MHz Range

The 0.009 MHz to 30 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The receive loop antenna was set to 1m above the ground plane with the Quasi-Peal detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data ws then stored on disk in sequential data files. The orientation of the receive loop antenna was varied to ensure that the emissions were maximised.

4.2.2 30 to 1000 MHz Range

The 30 MHz to 1000 MHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the Peak Detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Quasi-Peak detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.2.3 Above 1GHz

The testing above 1 GHz test frequency range was sub-divided into smaller bands with sufficient frequency resolution to permit reliable display and identification of possible EMI peaks while also permitting fast frequency scan times. The EUT was slowly rotated with the average detector set to Max-Hold. The EUT was further rotated through three orthogonal directions to ensure worst case emissions are measured. This was performed for two receiver antenna heights. Each significant peak was then investigated and maximised by rotating the turntable and scanning the height of the receiver antenna between 1 to 4 metres with the Average detector ON. The measurement data for each frequency range was automatically corrected by the software for cable losses, antenna factors and preamplifier gain and all data was then stored on disk in sequential data files. This process was performed for both horizontal and vertical receive antenna polarisation.

4.3 Plotting of Measurement Data for Radiated Emissions

4.3.1 0.009 to 30 MHz Range

The sored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 0.009 – 30 MHz. The fundamental frequency (H-Field_ was measured at the iOATS and the plot shown is from the Semi-Anechoic Chamber. The worst case radiated EMI *peak* measurements as recorded using the Max-Hold data are presented as the RED trace.

4.3.2 29 to 1000 MHz

The stored measurement data was combined to form a single graph which comprised of all the frequency sub-ranges over the range 29 to 1000 MHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Quasi-peak field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the quasi-peak level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the QP detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the quasi peak level higher than the peak level.

4.3.3 Above 1GHz

The stored measurement data was combined to form graphs which comprised of all the frequency sub-ranges over the range above 1 GHz. The accumulated EMI (EUT ON) was plotted as the Red trace while the Ambient signals (AMBIENT) were plotted as Green trace. The worst case radiated EMI peak measurements (as recorded using the Max-Hold data are presented as the upper or **RED** trace while the respective ambient signals are presented as the lower or **GREEN** trace. Occasionally, an intermittent ambient arose during the EUT ON measurement (RED trace) and could not be captured when the Ambient trace was being stored. The ambient peaks of significant amplitude with respect to the limit are tagged with the "#" symbol while EMI peaks are identified with a numeral. Ambient peaks that were present during the EUT ON measurement (RED trace) and not captured during the AMBIENT measurement were also tagged with "#" symbol.

The highest recorded EMI signals are shown on the Peaks List on the bottom right hand side of the graph. For radiated EMI, each numbered peak is listed as a frequency, peak field strength, Average field strength, limit and the margin relative to the limit in dB. A negative margin is the deviation of the recorded value below the limit. At times, the average level may appear to be higher than the peak level. This happens because the individual peak is further maximised with the Average detector AFTER the MAX-HOLD trace has been stored. This will be apparent when the peaks list at the foot of the graphs shows the average level higher than the peak level.

4.4 Calculation of Field Strength

The field strength was calculated automatically by the software using all the pre-stored calibration data. The method of calculation is shown below:

E = V + AF - G + L

Where: **E** = Radiated Field Strength in dBµV/m.
V = EMI Receiver Voltage in dBµV. (measured value)
AF = Antenna Factor in dB/m (stored as a data array)
G = Preamplifier Gain in dB. (stored as a data array)
L = Cable insertion loss in dB. (stored as a data array)

Example Field Strength Calculation
Assuming a receiver reading of 34.0 dBµV is obtained at 90 MHz, the Antenna Factor at that frequency is 9.2 dB. The cable loss is 1.9dB while the preamplifier gain is 20dB.

34.0 + 9.2 + 1.9 – 20 = 25.1 dBµV/m

4.5 Radiated Field Strength Measurement Results – Section 15.225

4.5.1 13.56MHz Carrier Field Strength Measurement at 3m Antenna Distance

Frequency MHz	Peak Level dBµV/m	Limit @ 3m dBµV/m	Result ± dB
13.56	15.80	124.00	-108.20
13.56	11.2	124.00	-112.80

The mains supply was varied as per Section 15.31e between 100V 60Hz to 138V 60Hz to determine if the carrier amplitude varies with supply voltage. No variation was recorded. The test was performed at 120V 60Hz.

Complied with a margin of at greater than 20dB with Section 15.225 Subpart a, b & c.
Refer to Appendix H, Graph 5.

4.5.2 Radiated Field Strength Measurements

All measurements were performed with a 3m antenna distance to the EUT.

4.5.2.1 0.009 MHz to 30 MHz

All measured frequencies complied with the quasi-peak limits by a margin of greater than 10dB.
Refer to Appendix H, Graphs 6 and 7.

4.5.2.2 29 MHz to 1000 MHz

Frequency (MHz)	Polarisation	Quasi Peak (dBµV/m)	Limit (dBµV/m)	Δ Limit (dB)
799.80	Vertical	42.0	46.0	-4.0
149.15	Vertical	39.5	43.5	-4.0
94.92	Vertical	39.3	43.5	-4.2
799.80	Horizontal	40.5	46.0	-5.5
600.00	Horizontal	39.7	46.0	-6.3
54.23	Vertical	32.9	40.0	-7.1
796.00	Vertical	38.9	46.0	-7.1
250.00	Horizontal	38.7	46.0	-7.3
796.59	Horizontal	41.6	46.0	-7.4
108.48	Vertical	35.6	43.5	-7.9
81.36	Horizontal	32.0	40.0	-8.0
600.00	Vertical	37.5	46.0	-8.5
40.687	Vertical	31.4	40.0	-8.6
135.60	Vertical	34.4	43.5	-9.1
122.04	Horizontal	34.1	43.5	-9.4

All measured frequencies complied with the quasi peak limits by a margin of at least 4.0dB.
Refer to Appendix H, Graphs 8 and 9.

4.5.2.3 Above 1000 MHz

Testing above 1000MHz was not applicable as the highest clock frequency in the EUT is less than 108MHz.

5.0 UNCERTAINTIES

EMC Technologies has evaluated the equipment and the methods used to perform the emissions testing. The estimated measurement uncertainties for emissions tests shown within this report are as follows:

Conducted Emissions

9kHz to 30 MHz	±3.2 dB

Radiated Emissions

9kHz to 30MHz	±4.1 dB
30MHz to 300MHz	±5.1 dB
300MHz to 1000MHz	±4.7 dB
1GHz to 18GHz	±4.6 dB

The above expanded uncertainties are based on standard uncertainties multiplied by a coverage factor of k=2, providing a level of confidence of approximately 95%.

6.0 FREQUENCY TOLERANCE (FCC Part 15 Sections 15.225e)

The frequency stability of the unit was verified under abnormal operating supply voltage and temperature.

FCC Sub Part C Section 15.225 e.

Supply Voltage Variation

The mains supply was lowered from 120V 60Hz to 102V (85% of nominal supply) and maintained until the frequency was stable. The mains supply was then increased from 120V 60Hz to 138V (115% of nominal supply) and maintained until the frequency was stable.

Nominal Voltage	Temperature	Voltage Variation	Frequency Reading [MHz]	Frequency Variation [%]
120 V	20℃	85% (102 V)	13.55993	0.001
120 V	20℃	115% (138 V)	13.55985	0.0

Maximum Frequency Variation to Nominal Frequency:	13.55985	0.001

The frequency tolerance of the carrier signal was maintained within ± 0.01% of the operating frequency during the voltage variation test.

Temperature Variation

The ambient temperature with a supply voltage of 120V 60Hz was varied between -20°C and +50°C. At each 10°C interval the temperature was maintained until the EUT temperature had stabilised. The frequency of the carrier was observed at each 10°C increments and compared to the nominal frequency.

Nominal Voltage	Ambient Temperature	Frequency Reading [MHz]	Frequency Variation [%]
120 V	-20℃	13.56008	0.002
120 V	-10℃	13.56008	0.002
120 V	0℃	13.55993	0.001
120 V	10℃	13.56015	0.002
120 V	20℃	13.55985	0.000
120 V	30℃	13.56013	0.002
120 V	40℃	13.56000	0.001
120 V	55℃	13.56025	0.003

Maximum Frequency Variation to Nominal Frequency:	13.55985	0.003

7.0 CONCLUSION

The RFID read-write reader with Model Number: MDR-3021AT and FCC ID: 2ACXQ-MDR-3021AT, complied with the requirements of FCC Part 15 Rules for an intentional radiator when tested in accordance with FCC Part 15.31e, 15.207 and 15.225.

Part 15.31e	
Amplitude stability with supply variation:	Complied
Part 15.207	
Conducted Emissions:	Complied
Part 15.225 a, b & c	
Carrier Signal Field Strength 13.110 – 14.010MHz:	Complied
Part 15.225 d (15.209)	
Field Strength Outside 13.110 – 14.010MHz:	Complied
Part 15.225 e	
Frequency Tolerance:	Complied

8.0 MEASUREMENT INSTRUMENTATION CALIBRATION DETAILS

Equipment Type	Make/Model Serial Number	Last Cal. DD/MM/YY	Due Date DD/MM/YY
EMI Receivers	HP8546A CISPR Receiver, 9kHz -6GHz S/N: 3549A00288	29/10/13	29/10/14 *2
EMI Receiver	ESCI Rohde Schwarz, 9kHz – 3GHz, S/N: 100012	13/03/14	13/03/15 *4
EMI Receiver	ESCI Rohde Schwarz, 20Hz – 40GHz, S/N: 100183	10/01/14	10/01/15 *4
LISN Single Phase:	EMCO 3825/2 SN 94112274	15/01/14	15/01/16 *3
LISN Single Phase:	Rohde & Schwarz ESH3-Z5 S/N 832479/014	07/01/14	07/01/16 *3
Transient Limiter	HP11947A, S/N: 3107A00857	10/07/13	10/09/14 *3
Antenna	EMCO 6502 Active Loop S/N 9108-2660, 9 kHz – 30 MHz	29/11/14	29/11/15 *1
Antenna	EMCO 3110B Biconical S/N 9603-2350, 20-300 MHz	05/02/14	05/02/16 *3
Antenna	EMCO 3146 Log Periodic S/N 9603-4415, 300-1000MHz	06/02/14	06/02/15 *3
Antenna	EMCO 3115 Horn Antenna S/N: 3823, 1-18GHz	16/01/12	16/01/15 *3
Preamplifier	PRA1G2-25B S/N 628, 30 to 1000 MHz	15/04/14	15/04/15 *3
60Hz Power Source	California Instrument, 5001 ix, Serial Number: 57006	NA	NA

Note *1 : National Measurements Laboratory calibration
Note *2 : NATA Calibration by VMS.
Note *3 : In-house calibration. Traceable to Australian National Standards.
Note *4: NATA Calibration by Rohde & Schwarz

TEST SITES

Equipment Type	Make/Model Serial Number	Last Cal. DD/MM/YY	Due Date DD/MM/YY
Shielded Room/ Test Laboratory	7.23m × 4.83m × 2.45m	N/A	N/A
Indoor Open Area Test Site (iOATS)	RFI Industries S800 Serial Number: 876, 3 metres iOATS situated at Seven Hills, NSW	29/11/13	29/11/14 *3