RF Exposure Lab

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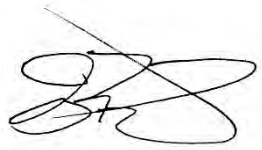
CERTIFICATE OF COMPLIANCE
RF EXPOSURE & NERVE STIMULATION EVALUATION

Toyota Material Handling, Inc.		Dates of Test:	June 19-20, 2024
5559 Inwood Drive		Test Report Number:	SAR.20240609
Columbus, IN 47201			Revision B
			Lab Designation Number: US1195

FCC ID:	2A226-TMHTWN4
Model(s):	DATWN4
Serial Number:	Eng 1
Equipment Type:	RFID Reader
Classification:	RFID Transmitter
TX Frequency Range:	125 kHz, 134 kHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	125 kHz – 3.01 dBm EIRP, 134 kHz – 3.01 dBm EIRP
Signal Modulation:	ASK
Antenna Type:	Internal
Application Type:	Certification
Standard(s):	KDB680106 D01 v04
Maximum E-Field	13.17 V/m
Maximum H-Field	0.42 A/m
Distance to Probe:	0 mm

This wireless mobile device has been shown to meet the requirements for RF exposure testing and Nerve Stimulation for uncontrolled environment/general exposure limits specified in above listed standards. The device has also been shown to meet the simultaneous requirements of each standard as well (See test report).

I attest to the accuracy of the data. I assume full responsibility for the completeness of these calculations and vouch for the qualifications of all persons making them.



Jay M. Moulton
Vice President

ACCREDITED
Testing Certificate # 2387.01

Table of Contents

1. Introduction 4
2. Radiation Sources 4
3. DATWN4 5
4. RF Exposure Classifications 6
5. RF Exposure Limits 7
FCC Requirements 7
6. General Conditions 8
7. Environmental Conditions 8
8. Test Equipment 8
9. EUT Description 9
10. Nerve Stimulation Evaluation Results 125 kHz 10
11. Nerve Stimulation Evaluation Results 134 kHz 14
Appendix A – Calibration Certificates 18

Comment/Revision	Date
Original Release	June 26, 2024
Revision A – Correct FCC ID and model	March 27, 2025
Revision B – Add probe diameter to page 8, removed the exponential and quartic evaluation & added the comparison evaluation for each set of data.	May 15, 2025

Note: The latest version supersedes all previous versions listed in the above table. The latest version shall be used.

1. Introduction

This report shows the RF exposure evaluation of the Toyota Material Handling, Inc. Model DATWN4 Wireless RFID Reader with KDB680106 D01 v04.

2. Radiation Sources

Radio	Description	
125 kHz	Frequency (MHz)	125 kHz
	Maximum Power (dBm)	3.01 dBm (EIRP)
	Maximum Duty Cycle (%)	100%
134 kHz	Frequency (MHz)	125 kHz
	Maximum Power (dBm)	3.01 dBm (EIRP)
	Maximum Duty Cycle (%)	100%

3. DATWN4

Photo Removed

Testing Position for RFID

4. RF Exposure Classifications

Device Types	
Fixed	A fixed device is defined as a device physically secured at one fixed location and cannot be easily re-located.
Mobile	A mobile device is defined as a transmitting device designed to be used in other than fixed locations and to generally be used in such a way that a separation distance of at least 20 centimeters is normally maintained between the transmitter's radiating structure(s) and the body of the user or nearby persons. (47 CFR 2.1091)
Portable	A portable device is defined as a transmitting device designed to be used so that the radiating structure(s) of the device is/are within 20 centimeters of the body of the user. (47 CFR 2.1093)

Exposure Categories	
Occupational / Controlled	Limits apply in situations in which persons are exposed as a consequence of their employment provided those persons are fully aware of the potential for exposure and can exercise control over their exposure. Limits for occupational/controlled exposure also apply in situations when an individual is transient through a location where occupational/controlled limits apply provided he or she is made aware of the potential for exposure.
General population / uncontrolled	Exposures apply in situations in which the general public may be exposed, or in which persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or cannot exercise control over their exposure.

5. RF Exposure Limits

FCC Requirements

The RF exposure limits, as set forth in § 1.1310, do not cover the frequency range below 100 kHz for Specific Absorption Rate (SAR) and below 300 kHz for Maximum Permitted Exposure (MPE). In addition, present limitations of RF exposure evaluation systems prevent an accurate evaluation of SAR below 4 MHz. For these reasons, a specific MPE-based RF Exposure compliance procedure for devices operating in the aforementioned low-frequency ranges has been set in place. This procedure is applicable to Equipment Authorization of all RF devices, thus including, but not limited to, Part 18 and WPT devices.

Accordingly, for § 2.1091-Mobile devices, the MPE limits between 100 kHz to 300 kHz are to be considered the same as those at 300 kHz in Table 1 of § 1.1310, that is, 614 V/m and 1.63 A/m, for the electric field and magnetic field, respectively. For § 2.1093-Portable devices below 4 MHz and down to 100 kHz, the MPE limits in § 1.1310 (with the 300 kHz limit applicable all the way down to 100 kHz) can be used for the purpose of equipment authorization in lieu of SAR evaluations.

Table 1 to § 1.1310(e)(1)—Limits for Maximum Permissible Exposure (MPE)

Frequency range (MHz)	Electric field strength (V/m)	Magnetic field strength (A/m)	Power density (mW/cm^2)	Averaging time (minutes)
(i) Limits for Occupational/Controlled Exposure				
0.3–3.0	614	1.63	*(100)	≤6
3.0–30	1842/f	4.89/f	*($900/f^2$)	<6
30–300	61.4	0.163	1.0	<6
300–1,500			f/300	<6
1,500–100,000			5	<6
(ii) Limits for General Population/Uncontrolled Exposure				
0.3–1.34	614	1.63	*(100)	<30
1.34–30	824/f	2.19/f	*($180/f^2$)	<30
30–300	27.5	0.073	0.2	<30
300–1,500			f/1500	<30
1,500–100,000			1.0	<30

f = frequency in MHz. * = Plane-wave equivalent power density.

6. General Conditions

- This report is only in reference to the item that has undergone the assessment.
- This report does not constitute or imply on its own an approval of the product by the Certification Bodies or Competent Authorities.

7. Environmental Conditions

The following limits were not exceeded during the test:

Temperature	Min. = 15 °C Max. = 35 °C
Relative Humidity	Min. = 30% Max. = 60%

8. Test Equipment

	Serial Number	Last Cal. Date	Cal. Due Date	Probe Diameter
• Wavecontrol SMP2	19SN1179	04/15/2024	04/15/2026	
• WP400-3	19WP120054	04/15/2024	04/15/2026	27 mm

- Positioning Apparatus used is a plastic tripod to hold the meter and probe at a specified position, a camera motion device is installed on the tripod to make precise positions at 10 mm steps away from the EUT
- Testing was conducted in a shielded room with the EUT sitting on a wooden table.
- A DC power source was used to supply the power to the EUT.
- The probes meet the requirements set forth in RSS-102.NS.MEAS Issue 1 sections 5.3.5 as required by table A2

9. EUT Description

The DATWN4 is an RFID Monitor that is to be installed on a material handling device (i.e., forklift, pallet jack, etc.) manufactured by Toyota Material Handling, Inc. The monitor provides RFID reader capability to the material handling device. There are three transmitters in the device (RFID at 125 kHz, RFID at 134 kHz and RFID at 13.56 MHz). The transmitters cannot be transmitting simultaneously; therefore, simultaneous evaluation is not required.

For the measurements, the device had a test code to set the transmitter to full power 100% duty cycle for testing. The testing at each measurement point was conducted for 1 minute to ensure the maximum power was detected.

The description of the antenna is listed below

- There is two antennas in the device one for the 125 kHz, 134 kHz and one for 13.56 MHz transmitters
- The element is a 3 turn coil antenna for the 13.56 MHz transmitter and 123 turn coil antenna for the 125 kHz/134 kHz transmitters with an impedance of 68 Ω for the 13.56 MHz transmitter and 2.4 kΩ for the 125 kHz/134 kHz transmitters
- The shielding or field shaping is not applicable
- The overall dimensions of the device is 20 cm x 13 cm x 9 cm
- The distance from the antenna to the outside of the enclosure is 10 cm
- The position of the antenna in the device is located on the bottom side of the monitor
- The enclosure over the antenna is Sabic Lexan EXL9330-GY2E408 Unfilled PC+Siloxade resin
- D_s of the transmitting antenna is 45 mm x 32 mm rectangle
- The nominal voltage supplied is 5 volts and the nominal current supplied is 120 mA.
- The maximum voltage supplied is 5.5 volts and the maximum current supplied is 150 mA.

10. Nerve Stimulation Evaluation Results 125 kHz

The measurements for the DATWN4 was conducted at 20 mm distance from the device to the center of the probe diameter. A pre-scan of the around the antenna was conducted first by moving the probe around all areas of the device being tested. The movement was conducted at a very slow pace to find the peak value for the device. Once the peak position was determined for the device, the meter and probe were installed on the positioning apparatus for conducting the final measurements. The location of the highest value was at x=-7 mm, y=-10 mm, z=20 mm. The grid is based on the center of the antenna being 0,0,0 mm.

Below are all the measured values for the e- and h-field. All evaluations were conducted with a 95% confidence.

E-field		H-field	
Distance	**Measured Value**	**Distance**	**Measured Value**
20 mm	11.96	47 mm	0.334
30 mm	9.50	48 mm	0.249
40 mm	9.08	49 mm	0.184
50 mm	7.23	50 mm	0.138
60 mm	7.18	60 mm	0.111
70 mm	6.96	70 mm	0.091
80 mm	6.85	80 mm	0.077
90 mm	6.03	90 mm	0.068
100 mm	6.53	100 mm	0.061
110 mm	5.39	110 mm	0.057
120 mm	6.19	120 mm	0.054
130 mm	5.92	130 mm	0.053
140 mm	4.80	140 mm	0.051
150 mm	5.17	150 mm	0.050

The highest value of all the sides at 20 mm was then tested at 20 mm moving away from the device every 10 mm. All the values were used to extrapolate to the 0 mm distance. The equation used to extrapolate the value to zero is the second degree polynomial $y = a_2x^2 + a_1x + a_0$, where x is the distance and y is the extrapolated value. This form of regression is quadradic regression decay. This evaluation is evaluating the value down to 0 mm using the first measurement at 20 mm.

The extrapolated value at 10 mm is 11.94 V/m.
The extrapolated value at 0 mm is 13.08 V/m.

Regression Statistics	
Multiple R	0.950149348
R Square	0.902783784
Adjusted R Square	0.885108108
Standard Error	0.658778215
Observations	14

The extrapolated value at 10 mm is 0.36 A/m.
The extrapolated value at 0 mm is 0.42 A/m.

Regression Statistics	
Multiple R	0.980547571
R Square	0.961473539
Adjusted R Square	0.954468728
Standard Error	0.018477235
Observations	14

The highest value of all the sides at 20 mm was then tested at 50 mm moving away from the device every 10 mm. All the values were used to extrapolate to the 0 mm distance. The equation used to extrapolate the value to zero is the second degree polynomial $y = a_2x^2 + a_1x + a_0$, where x is the distance and y is the extrapolated value. This form of regression is quadradic regression decay. This evaluation shows the verification of the extrapolation using the data from 50 mm on to compare a calculated value with a measured value.

The extrapolated value at 40 mm is 9.08 V/m.
The extrapolated value at 20 mm is 10.90 V/m.

The measured value at 40 mm is 9.08 V/m
The measured value at 20 mm is 11.96

The E-Field comparison is within 10%.

The extrapolated value at 40 mm is 0.20 A/m.
The extrapolated value at 20 mm is 0.30 A/m.

The measured value at 40 mm is 0.184 A/m.
The measured value at 20 mm is 0.334 A/m.

The H-Field comparison is within 12%.

Table of Regression Statistics				
	Multiple R	**R ^ 2**	**Adjusted R ^ 2**	**Standard Error**
Quadradic E-Field	0.950149348	0.902783784	0.885108108	0.658778215
Quadradic H-Field	0.980547571	0.961473539	0.954468728	0.018477235

Comparison of the Three Interpolations		
	E-Field	**H-Field**
Quadradic	13.08	0.42

Frequency	E-Field Measurement	Limit [V/m]	% Limit	Verdict
125 kHz	13.08	614	2.1	Pass

Frequency	H-Field Measurement	Limit [A/m]	% Limit	Verdict
125 kHz	0.42	1.63	25.8	Pass

11. Nerve Stimulation Evaluation Results 134 kHz

The measurements for the DATWN4 was conducted at 20 mm distance from the device to the center of the probe diameter. A pre-scan of the around the antenna was conducted first by moving the probe around all areas of the device being tested. The movement was conducted at a very slow pace to find the peak value for the device. Once the peak position was determined for the device, the meter and probe were installed on the positioning apparatus for conducting the final measurements. The location of the highest value was at x=-7 mm, y=-10 mm, z=20 mm. The grid is based on the center of the antenna being 0,0,0 mm.

Below are all the measured values for the e- and h-field. All evaluations were conducted with a 95% confidence.

E-field		H-field	
Distance	**Measured Value**	**Distance**	**Measured Value**
20 mm	12.09	47 mm	0.319
30 mm	9.34	48 mm	0.235
40 mm	9.33	49 mm	0.186
50 mm	7.22	50 mm	0.138
60 mm	7.25	60 mm	0.110
70 mm	6.99	70 mm	0.088
80 mm	6.82	80 mm	0.077
90 mm	5.97	90 mm	0.067
100 mm	6.45	100 mm	0.061
110 mm	5.40	110 mm	0.057
120 mm	6.26	120 mm	0.054
130 mm	5.89	130 mm	0.052
140 mm	4.76	140 mm	0.051
150 mm	5.14	150 mm	0.050

The highest value of all the sides at 20 mm was then tested at 20 mm moving away from the device every 10 mm. All the values were used to extrapolate to the 0 mm distance. The equation used to extrapolate the value to zero is the second degree polynomial $y = a_2x^2 + a_1x + a_0$, where x is the distance and y is the extrapolated value. This form of regression is quadradic regression decay. This evaluation is evaluating the value down to 0 mm using the first measurement at 20 mm.

The extrapolated value at 10 mm is 12.02 V/m.
The extrapolated value at 0 mm is 13.17 V/m.

Regression Statistics	
Multiple R	0.947002607
R Square	0.896813938
Adjusted R Square	0.878052836
Standard Error	0.691829108
Observations	14

The extrapolated value at 10 mm is 0.34 A/m.
The extrapolated value at 0 mm is 0.40 A/m.

Regression Statistics	
Multiple R	0.98327574
R Square	0.966831181
Adjusted R Square	0.960800487
Standard Error	0.0163121
Observations	14

The highest value of all the sides at 20 mm was then tested at 50 mm moving away from the device every 10 mm. All the values were used to extrapolate to the 0 mm distance. The equation used to extrapolate the value to zero is the second degree polynomial $y = a_2x^2 + a_1x + a_0$, where x is the distance and y is the extrapolated value. This form of regression is quadradic regression decay. This evaluation shows the verification of the extrapolation using the data from 50 mm on to compare a calculated value with a measured value.

The extrapolated value at 40 mm is 9.13 V/m.
The extrapolated value at 20 mm is 10.97 V/m.

The measured value at 40 mm is 9.33 V/m
The measured value at 20 mm is 12.09

The E-Field comparison is within 11%.

The extrapolated value at 40 mm is 0.20 A/m.
The extrapolated value at 20 mm is 0.29 A/m.

The measured value at 40 mm is 0.186 A/m.
The measured value at 20 mm is 0.319 A/m.

The H-Field comparison is within 10%.

Table of Regression Statistics				
	Multiple R	**R ^ 2**	**Adjusted R ^ 2**	**Standard Error**
Quadradic E-Field	0.947002607	0.896813938	0.878052836	0.691829108
Quadradic H-Field	0.98327574	0.966831181	0.960800487	0.0163121

Comparison of the Three Interpolations		
	E-Field	**H-Field**
Quadradic	13.17	0.40

Frequency	E-Field Measurement	Limit [V/m]	% Limit	Verdict
134 kHz	13.17	614	2.1	Pass

Frequency	H-Field Measurement	Limit [A/m]	% Limit	Verdict
134 kHz	0.40	1.63	24.5	Pass

Appendix A – Calibration Certificates

Certificate of Calibration

ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994

Certificate Number 240411-151731-99c41b

ACCREDITED
ISO/IEC 17025
CALIBRATION LABORATORY
AC-1498.20

Model Number	WP400-3; SMP2
Manufacturer	Wavecontrol
Description	Field Probe
Serial Number	19WP120054; 19SN1179
Customer Asset No.	N/A

Customer
RF Exposure Lab, LLC
802 N. Twin Oaks Valley Rd
Suite 105
San Marcos, CA 92069
USA

Date of Calibration	04/15/2024
Temperature	24°C
Humidity	30% RH

Location of Calibration
Keysight Technologies Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

This certifies that the equipment has been calibrated using applicable Keysight Technologies procedures and in compliance with ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994 (R2002). The quality management system is registered to ISO 9001:2015.

Calibration Standard(s)
IEEE Std 1309-2013

Calibration Method(s)
Substitution

Calibration Procedure(s)
909579

Calibration Software
Probe Comparison 1.5.2

As Received Conditions
The measured values of the equipment were observed in specification at the points tested.

Action Taken
No action was taken.

As Completed Conditions
The measured values of the equipment were observed in specification at the points tested.

Calibration Due
Based on the customer's request, the next calibration is due on 15 Apr 2026

Remarks or Special Requirements

This calibration report shall not be reproduced, except in full. The documented results relate to the equipment calibrated only.

The test limits stated in the report correspond to the published specifications of the equipment, at the points tested.

Keysight Technologies, Inc.
1346 Yellowwood Road
Kimballton, IA 51543
United States

Brandt Langer Iowa Service Center Manager

Certificate of Calibration

ISO/IEC 17025:2017 and ANSI/NCSL Z540.1-1994

Certificate Number 240411-151731-99c41b

Traceability Information

Technician Name Dave Grabill

Measurements are traceable to the International System of Units (SI) via national metrology institutes (www.keysight.com/find/NMI) that are signatories to the CIPM Mutual Recognition Arrangement.

Calibration Equipment Used

Manufacturer	Model Number	Model Description	Equipment ID	Cal Due Date	Certificate Number
Agilent Technologies, Inc.	33250A	Function/Arbitrary Waveform Generator	11101	06/30/2024	230601-152459-8b26d8
AR	350AH1	Amp	11453	NA	NA
Hewlett-Packard	8563E	Spectrum Analyzer	2084	11/30/2024	231026-133128-431894
Combinova	FD1	Field Detector	10348	01/31/2025	240117-073922-a02261
Combinova	FD2	Field Detector	10347	02/28/2025	240202-080515-3d46de
Schwarzbeck Mess-Elektronik	FESP 5133-7/41	Loop	11285	10/31/2024	231026-131402-6bd9de
Schwarzbeck Mess-Elektronik	HHS 5204-12	Helmholtz Coil	11091	NA	NA
Holaday	HI-3624	ELF Magnetic Field Meter	10569	09/30/2024	230915-073549-c990d5
Holaday	HI-3627	ELF Magnetic Field Meter	10570	03/31/2025	240312-074557-4a2507

Compliance with Specification

Unless otherwise noted, the calibration results are reported without factoring in the effect of uncertainty on the assessment of compliance/specification.

In Specification/Out of Specification Explanation

The standard criteria to determine the "In Specification/Out of Specification" status is based on one or more of the following conditions, as requested by the client:

1. If the manufacturer has a specified specification for the item being calibrated, then the calibration values are compared to this specification, and the values must fall within the manufacturer's specification. The specification may be obtained from the manufacturer's web site, data sheets, equipment manuals, etc.
2. Where specifications are called out in a published standard, the calibration results are compared to this specification, and the measured values must fall within the standard's specification.
3. In cases where the manufacturer, standard, or client does not identify any relevant specifications, applicable calibration results are compared to historical data with a +/- 3 dB specification.

Uncertainty of Measurement

The uncertainty evaluation has been performed in accordance with ISO/IEC Guide 98-3:2008(GUM). The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k such that the coverage probability corresponds to approximately 95%. This probability corresponds to a coverage factor of k=2 for a normal distribution.

Parameter	Range	MU (+/-)
Magnetic Field Strength Meters - AC	0.20 mG to 20 G	0.33% + 1.2 mG

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WP400-3; SMP2
Probe Serial No.: 19WP120054; 19SN1179
Notes:
CAL CERT #: 240411-151731-99c41b

Magnetic Field

Linearity - 50Hz

B Field (uT)	X axis CF	X axis dB	Y axis CF	Y axis dB	Z axis CF	Z axis dB	Mean CF
750	0.99	-0.12	0.99	-0.11	0.99	-0.12	0.99
500	0.97	-0.23	0.97	-0.24	0.97	-0.25	0.97
250	1.01	0.10	1.01	0.07	1.01	0.06	1.01
100	0.98	-0.16	0.98	-0.17	0.98	-0.19	0.98
50	1.00	0.02	1.00	-0.02	0.98	-0.19	0.99
10	1.05	0.43	1.04	0.33	1.03	0.22	1.04
5	0.96	-0.38	0.96	-0.31	0.94	-0.52	0.95

Frequency Response
10Hz-2kHz: 100uT / 10-200kHz: 25uT

Freq Hz	X axis CF	X axis dB	Y axis CF	Y axis dB	Z axis CF	Z axis dB	Mean CF
10	1.07	0.59	1.06	0.51	1.06	0.50	1.06
30	1.00	0.04	1.00	-0.01	1.00	0.01	1.00
60	0.98	-0.16	0.98	-0.17	0.98	-0.20	0.98
100	0.98	-0.22	0.98	-0.21	0.97	-0.22	0.98
500	1.01	0.08	1.01	0.07	1.00	-0.02	1.01
1000	0.99	-0.09	0.99	-0.08	0.98	-0.17	0.99
2000	0.99	-0.06	0.99	-0.08	0.99	-0.12	0.99
10000	0.85	-1.41	0.85	-1.38	0.85	-1.38	0.85
100000	0.84	-1.48	0.84	-1.52	0.85	-1.45	0.84
200000	0.81	-1.84	0.81	-1.87	0.80	-1.90	0.81

Customer Name: RF Exposure Lab, LLC
Probe Manufacturer: Wavecontrol
Probe Model: WP400-3; SMP2
Probe Serial No.: 19WP120054; 19SN1179
Notes:
CAL CERT #: 240411-151731-99c41b

Electric Field

Linearity - 50Hz

E Field (V/m)	X axis CF	X axis dB	Y axis CF	Y axis dB	Z axis CF	Z axis dB	Mean CF
350	1.00	-0.02	0.99	-0.05	1.00	-0.02	1.00
250	1.00	-0.01	1.00	0.03	1.00	0.04	1.00
100	1.01	0.05	1.01	0.08	1.01	0.05	1.01
50	1.03	0.24	1.02	0.16	1.02	0.15	1.02
20	1.02	0.14	1.01	0.12	1.02	0.18	1.02

Frequency Response

25Hz-100kHz: 350V/m / 10Hz, 200-400kHz: 300V/m

Freq Hz	X axis CF	X axis dB	Y axis CF	Y axis dB	Z axis CF	Z axis dB	Mean CF
10	1.23	1.83	1.23	1.80	1.24	1.84	1.23
25	1.12	0.96	1.12	0.98	1.12	0.98	1.12
50	1.00	-0.02	1.00	-0.02	1.00	-0.03	1.00
100	0.99	-0.08	0.99	-0.09	0.99	-0.09	0.99
500	0.99	-0.08	0.99	-0.09	0.99	-0.08	0.99
1000	0.98	-0.21	0.98	-0.20	0.97	-0.23	0.98
2000	1.02	0.18	1.02	0.16	1.02	0.14	1.02
10000	1.02	0.20	1.02	0.19	1.02	0.19	1.02
100000	1.04	0.32	1.04	0.32	1.04	0.32	1.04
200000	1.02	0.17	1.02	0.16	1.02	0.16	1.02
300000	1.02	0.19	1.02	0.19	1.02	0.18	1.02
400000	1.06	0.49	1.06	0.51	1.06	0.48	1.06