

MBARI Field Verification of Safety Zone

This document contains MBARI's plan to verify in the field the estimated 160dB, 500-foot marine mammal safety zone around the plow to be used to bury the MARS cable. This plan includes the use of a hydrophone and MBARI's Research Vessel *Zephyr*. MBARI will adjust the safety zone outward to the appropriate distance, if necessary, based on results of this testing procedure.

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REVISION HISTORY					
REV	DESCRIPTION	DATE	APPROVED		
-	INITIAL RELEASE				

CONTRACT NO.		 Monterey Bay Aquarium Research Institute 7700 Sandholdt Road Moss Landing, CA 95039			
APPROVALS	DATE	MARS INSTALLATION SHIP AND PLOW ACOUSTIC CHARACTERIZATION TEST PLAN			
DRAWN					
CHECKED Keith Raybould	10/10/05				
ENGR Gene Massion	10/10/05				
DESIGN ACTIVITY MBARI		SIZE A	CAGE CODE	DWG. NO. 1002895	REV -
		SCALE: N/A FILE: KARAKATOA/C:/MARS/AcTestPlan-IR.doc			

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1. Scope

This document will describe the tests that will be performed to characterize the acoustic emissions of the cable ship and burial plow used for the MARS installation.

2. Referenced Documents

- 2.1. ITC 8201 hydrophone
- 2.2. Agilent 33562A Dynamic signal analyzer
- 2.3. R/V Zephyr description

3. Required Test Equipment

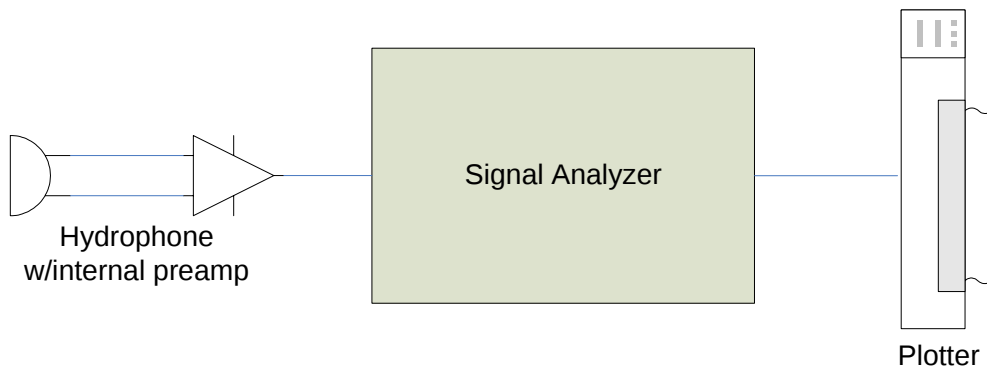
TEST EQUIPMENT	SERIAL NUMBER
ITC 8201 Hydrophone	
Agilent 35665A Dynamic Signal Analyzer	
HPIB Plotter	
NOTE: Equivalent equipment may be substituted as equipment is upgrade. Log actual equipment, SN and cal dates used for test	

4. Required Test Software

None

5. Test setup

A block diagram of the test setup is shown below.



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6. Test Procedure

A qualified observer must be onboard the installation vessel during these tests. Ensure no marine mammals are within 1000 meters of the installation vessel or plow while these tests are conducted.

6.1. Setup

Attach the hydrophone to the Zephyr hydrophone pole such that the boat can maintain orientation relative to the installation vessel/plow such that the vessel/plow is centered on the hydrophone beam pattern

6.2. Background noise measurement

While the installation ship is at least 20 km away, allow the Zephyr to drift with all machinery off and acquire a power spectrum using the DSA. Use enough averages to ensure the amplitude variation is less than ~5%. Set up the cursors to measure total power in the band 0-100 kHz. Record the measurement to disk. Fill out all data blocks in the data sheet. Make a hard copy record of the spectrum on the plotter. Label data file and hardcopy.

6.3. Ship only measurement

6.3.1. Starboard side

With the Zephyr ~200 meters off the starboard side of the installation vessel, before the plow is deployed, while the vessel is maintaining station at the deployment start location, acquire a power spectrum using the DSA. Adjust the DSA vertical scale (amplitude) and number of averages as necessary, leave the rest of DSA configuration as in 6.2. Record the measurement to disk. Fill out all data blocks in the data sheet. Make a hard copy record of the spectrum on the plotter.

6.3.2. Bow on

Repeat 6.3.1 with the Zephyr ~200 meters of the bow of the installation vessel.

6.3.3. Port side

Repeat 6.3.1 with the Zephyr ~200 meters of the port side of the installation vessel.

6.4. Ship and plow measurement

6.4.1. Starboard side

With the Zephyr ~200 meters off the starboard side of the installation vessel with the plow in operation, repeat 6.3.1.

6.4.2. Bow on

With the Zephyr ~200 meters off the bow of the installation vessel with the plow in operation, repeat 6.3.1.

6.4.3. Port side

With the Zephyr ~200 meters off the port side of the installation vessel with the plow in operation, repeat 6.3.1.

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6.5. Calculations

Correct the total power measurement in a 0-100 kHz band using the actual measurement range to get the emitted power at 1 meter.

6.6. Test Report

The test report shall include a copy of this test procedure, the filled out data sheet, all measurement hard copies and a floppy disk with the recorded measurements

6.7. Data Sheet

Date:		
Test Engr:		
6.2 Background Noise Measurements		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		

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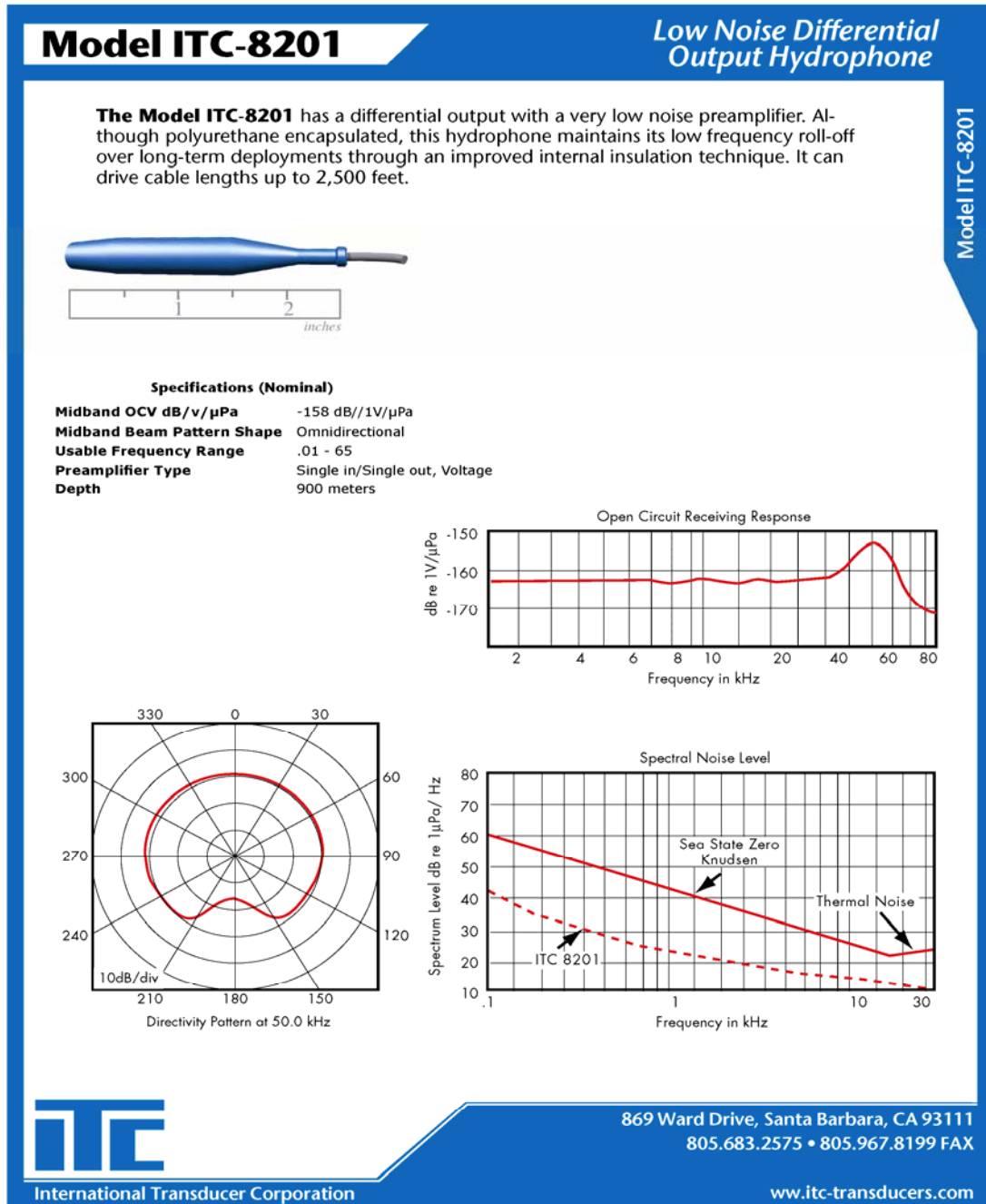
6.3.1 Ship only, starboard side measurement		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		
6.3.2 Ship only, bow on measurement		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		
6.3.3 Ship only, port side measurement		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		

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6.4.1 Ship + plow, starboard side measurement		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		
6.4.2 Ship + plow, bow on measurement		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		
6.4.3 Ship + plow, port side measurement		
	Latitude	Longitude
Inst. Ship Pos:		
Zephyr Pos:		
Range:		
Data file name:		
Noise power 0-100 kHz re 1 uPa @ 1 meter		
Comments:		

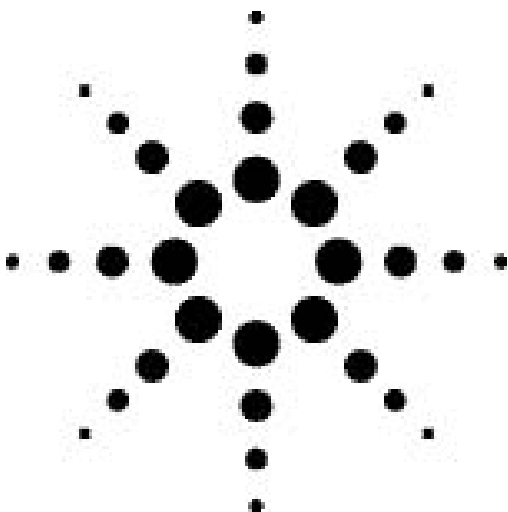
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6.8 Reference Documents



35665A 2-Channel DC to 102.4 kHz Dual Channel Dynamic Signal Analyzer

Data Sheet



Product Specifications

Frequency

RANGE

One Channel Mode (CH. 1): 102.4 kHz

Two Channel Mode (Ch 1 & 2): 51.2 kHz

RESOLUTION

100, 200, 400 or 800 lines resolution

Frequency resolution = frequency span/number of lines resolution

Minimum frequency resolution

One Channel Mode: 244 uHz

Two Channel Mode: 122 uHz

SPANS

One Channel Mode: 102.4 kHz to 0.19531 Hz

Two Channel Mode: 51.2 kHz to 0.097656 Hz

ACCURACY ± 30 ppm

Real Time Bandwidth

Fast Average On: ≥ 12.8 kHz

MEASUREMENT RATE

401 point FFT display, fast average on

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One Channel mode: ≥ 33 averages/second (typical)

Two channel mode: ≥ 15 averages/second (typical)

DISPLAY UPDATE RATE: ≥ 8 updates/second (typical)

401 point FFT display, fast average off

Amplitude/Phase

INPUT RANGES (full scale): +27 dBVrms (31.7 Vpk) to -51 dBVrms (3.99 mVpk) in 2 dB steps AMPLITUDE

RESOLUTION: 0.016% of full scale (typical)



ABSOLUTE AMPLITUDE ACCURACY: $\pm 2.92\%$ (0.25 dB) of reading $\pm 0.025\%$ of full scale

CROSS-CHANNEL GAIN ACCURACY Source = Full scale: ± 0.04 dB Source = -20dB full scale: ± 0.08 dB

CROSS-CHANNEL PHASE ACCURACY Source = full scale: ± 0.5 deg Source = -20 dB full scale: ± 0.5 deg

Dynamic Range

FULL SPAN FFT NOISE FLOOR

Input Range 27 to -35 dBVrms: < -76 dBfs (-85 dBfs typical)

Input Range -37 to -51 dBVrms: $< (-112 - \text{Range})$ dBfs

SPURIOUS FREE DYNAMIC RANGE: < -72 dBfs

(Includes Spurs, Harmonic Distortion, Intermodulation Distortion, Alias Products)

Zoom Mode Alias Responses

1.5% to 98.5% of the Frequency Span: < -72 dBfs

Lower and Upper 1.5% of Frequency Span: < -65 dBfs

INPUT NOISE LEVEL Above 1280 Hz: < -140 dBVrms / (Sq. R) Hz 160 Hz to 1.28 kHz

(6.4kHz span): < -130 dBVrms / (Sq. R) Hz

Input

INPUT RANGES: -51 dBVrms to +27 dBVrms

INPUT IMPEDANCE: 1M ohm $\pm 30\%$ $< \text{or} = 100$ pico Farad

Low Side to Chassis Impedance Floating Mode: 1M ohm $\pm 30\%$

(typical)

< 0.01 micro Farad (typical)

AC COUPLING: < 3 dB Rolloff at 1Hz

COMMON MODE REJECTION

-51 dBVrms to -11 dBVrms Ranges: > 80 dB (typical)

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-9 dBVrms to +9 dBVrms Ranges: >60 dB (typical)
+11 dBVrms to +27 dBVrms Ranges >40 dB (typical)

COMMON MODE RANGE (floating mode): ± 4 V pk

IEPE SIGNAL CONDITIONING Current Source: 4.25 ± 1.5 mA Open Circuit voltage: +26 to +32 Vdc

Trigger/Tachometer



TRIGGER MODES: Internal, External TTL, Source, HP-IB MAXIMUM TRIGGER DELAY

Post Trigger: 8191 seconds Pre Trigger: 8191 samples PULSES PER REVOLUTION: 0.5, 1 to 2048 (Integer Steps) RPM ACCURACY: ± 100 ppm TRIGGER LEVEL RANGE

Low Range: -4V to +4V

High Range: -20V to +20V TRIGGER LEVEL RESOLUTION Low range: 100 mV High Range: 500 mV

RPM RANGE: $5 < \text{RPM} < 220,759$ MAXIMUM TRIGGER PULSE RATE: 800 kHz

Source Output

AMPLITUDE RANGE: ± 5 V peak AMPLITUDE RESOLUTION

Voltage ≥ 0.2 Vrms: 2.5 mVpeak Voltage < 0.2 Vrms: 0.25 mVpeak RESIDUAL DC OFFSET: ± 10.0 mV

OUTPUT IMPEDANCE: < 5 ohms SOURCE TYPE: Sine, random, pink noise, chirp

Options

COMPUTED ORDER TRACKING

Pulses per Revolution: 0.5, 1 to 2048 (integer steps) (Max Order x Max RPM) / 60

On line (real-time) 1 Channel Mode: $\leq$ to 25,600 Hz 2 Channel Mode: $\leq$ to 12,800 Hz

Capture playback 1 Channel Mode: $\leq$ to 102,400 Hz 2 Channel Mode: $\leq$ to 51,200 Hz

Specified for $5 < \text{RPM} < 220,759$ RPM (on line) $5 < \text{RPM} < 491,519$ RPM (capture playback); and Number of Orders $< \text{or} = 200$.

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Software Limits at $5 \leq \text{RPM} \leq 491,519$;
and Number of Orders ≤ 200
Delta Order: $1/128$ to $1/1$

Resolution
(Maximum Order) / (Delta Order): < 200

RPM Accuracy: ± 100 ppm

Maximum RPM Ramp Rate: 750 RPM/second (typical)
1 and 2 Channel Mode
1000 to 10,000 RPM Run-up
Maximum Order = 10
Delta Order = 0.1
RPM Step = 30

REAL TIME OCTAVE ANALYSIS - OPTION 1D1

STANDARDS

ANSI Standard S1.11 - 1996, Order 3, Type 1-D, Extended and
Optional Frequency Ranges
IEC Standard 651-1979 Type 0 Impulse, and ANSI S1.4

$1/1$ OCTAVE RANGE (at centers): 0.0613 Hz to 16 kHz

$1/3$ OCTAVE RANGE (at centers): 0.08 Hz to 32 kHz

$1/12$ OCTAVE RANGE (at centers): 0.09145 Hz to 12.338 kHz

$1/3$ OCTAVE UPDATE RATE

1 Channel Mode
16 kHz Bandwidth 12 Updates/Second (Typical)
32 kHz Bandwidth 5 Updates/Second (Typical)
2 Channel Mode 8 Updates/Second (Typical)
(16 kHz, 32 kHz Bandwidths)

$1/3$ OCTAVE DYNAMIC RANGE

2 Second Stable Average: > 80 dB as per ANSI S1.11-1986
Total power limited by the for full scale ranges from
input noise level 50 mV_{peak} to 31.7 V_{peak}

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STABLE AVERAGE RANGE

One Channel Mode Real-Time Bandwidth = 32 kHz

Two Channel Mode Real-Time Bandwidth = 16 kHz

SWEPT SINE MEASUREMENTS - OPTION 1D2

DYNAMIC RANGE: >130 dB (typical)

Input auto range on

100 msec integration

SWEEP TIMES:

51.2 Hz to 51.2 kHz span 11 dBV rms source level 100 ms integration

time approximately 76 sec (typical) 10 ms integration time

approximately 25 sec (typical) 5 cycle integration time approximately 16

sec (typical) 100 cycle integration time approximately 25 sec (typical)



CROSS-CHANNEL AMPLITUDE/PHASE ACCURACY Ch. 1 range = Ch. 2 range: ± 0.04 dB ± 0.5 deg

Abbreviations

Zoom mode = Start frequency >0 Hz dBVrms = dB relative to 1 Volt rms. dBfs = dB relative to full scale amplitude range. Full scale is approx. 2 dB below ADC overload. FS is fs = Full Scale; synonymous with Input Range. RS = Resistance of source or termination connected to Agilent 35665A's input (from high to low). Vs = voltage applied to Agilent 35665A's input. Vpk = Peak of the ac Voltage Rload = Load resistance connected to Agilent 35665A's source CF = center frequency Typical = typical, non-warranted, performance specification included to provide general product information

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Vessels and Vehicles - R/V Zephyr

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Marine Operations

Vessels and Vehicles - R/V Zephyr

More on the R/V Zephyr



SPECIFICATIONS

- Length Overall: 85 ft
- Beam: 23.5 ft
- Gross tonnage: 119 tons
- Horse Power: 840 SHP
- Speed: 12 knots
- Endurance: 2500 NM @10 knts
- Fuel Capacity: 3600 gal
- Potable Water: 1000 gal
- Lube Oil: 100 gal
- Grey Water: 300 gal
- Berthing: 10
- Draft 8 ft

CREW REQUIREMENTS

Master	Aaron Gregg	aaron@mbari.org
Bosun/Engineer	Matthew Noyes	mnoyes@mbari.org
Relief Captain	Steve Etchemendy	etst@mbari.org
6 AUV Technicians	Optional	Dorado Home
6 Science Complement	Optional	MBARI Staff

ENGINEERING MACHINERY

- 2 D343 Caterpillar (mains)
- 2 Northern Lights 40 kw generators
- 2 Air Compressors Quincy QR-25 150 psi system

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Vessels and Vehicles - R/V Zephyr

- 2 Independent Hydraulic Systems 3000psi@ 13gpm

DECK MACHINERY

- 1 Hiab 31 Sea Crane 3000psi
Safe working loads (SWL):
SWL 1365 lbs. fully extended 15' 8"
SWL 1650 lbs. at 13' 2"
SWL 2200 lbs. at 9' 9"
SWL 3675 lbs. at 5' 6"
- 1 Brooke Ocean Technologies Articulated J-frame with removable AUV Launch & Recovery System.
J-frame has a 2400 lb. SWL with a 130 deg. rotation. Maximum tow of 1000 lbs.
Note: The J-frame is not designed for towing small towfish, nets, or anything requiring more than 1000 total pounds of pull.
- 1 AUV *Dorado*
- Removable 10HP electro-hydraulic winch (.25-inch wire). Operational rating of 812 lbs at full drum (safe working load).
- Vertical capstan - 1700 lbs. of pull.
- Retractable diving platform.
- Removable CTD - SBE 19 plus profiler and a SBE 32 carousel water sampler.

SAFETY EQUIPMENT

- 1 10 ft Avon rigid inflatable with 6 hp 4 stroke Honda outboard
- 1 300# CO2 fixed engine room fire system
- 2 Fixed Sea Water Hose Stations on deck
- 15-person inflatable liferaft
- 406 Mhz EPIRB with GPS transponder
- 10 adult immersion suits
- 8 type III work vests
- 24 type I life vests

ELECTRONICS/COMMUNICATIONS

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Vessels and Vehicles - R/V Zephyr

- Call Sign WDA 6249
- 2 VHF Horizon Spectrum, Shipmate RS 8300
- 1 SSB SEA 330
- 2 Motorola Cellular SCN 2449A
- 2 Furuno FR-805-D 48-mile Radars
- 1 Garmin GPS with CG diff
- Winfrog Electronic Charting and Navigation System (data logging capabilities)
- Iridium voice/data
- VHF and UHF radio direction finder
- Sonardyne USBL
- Freewave data radio
- 802.11 wifi

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