



US Smart Outlet

Purchase Specification

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TABLE OF CONTENTS

1	INTRODUCTION	1
1.1	Executive Summary.....	1
1.2	About This Specification	1
1.3	Related Documents	1
2	PRODUCT DESCRIPTION	2
2.1	Features.....	2
2.2	Electronic Hardware Description	2
2.2.1	Block Diagram.....	3
2.3	Relay.....	3
3	Performance Specifications	4
3.1	Reliability	4
3.1.1	Reliability Testing	4
3.2	Power.....	4
3.2.1	Power Source.....	4
3.2.2	Power Consumption.....	4
3.2.3	Noise Rejection	4
3.2.4	Power Cycling	4
3.3	Sub-metering Accuracy	5
3.4	Radio	5
3.4.1	HAN Radio Specifications.....	5
3.4.2	Channel Tx Power.....	5
4	Physical Specifications.....	6
4.1	Dimensions	6
4.2	Appearance	6
4.3	LEDs	6
4.4	Button	7
4.5	Device Labeling	7
4.5.1	Housing and Agency Label	7
4.5.1.1	Company and Product Name	7
4.5.1.2	Tendrill Logo.....	7
4.5.1.3	Model Number	7
4.5.1.4	Label Example	7
4.6	ESD Failure Level Limits	8
4.7	Environmental Specifications	9
4.7.1	Altitude	9
4.7.2	Temperature.....	9
4.7.3	Humidity	9
4.7.4	Actual Environmental Test Corners	9
4.8	Shock and Vibration Specifications	10
4.8.1	Transportation Vibration.....	10
4.8.2	Transportation Drop	10
4.8.3	Non-Operational Shock.....	10
4.8.4	Non-Operational Vibration	11
4.8.5	Operational Random Vibration.....	11
5	Installation.....	12
5.1	Location	12
5.2	Maintenance / Service	12

6 Manufacturing / Test Specifications 12

- 6.1 Manufacturing Process..... 12
- 6.2 Minimum Testing Requirements..... 12

7 Agency Requirements..... 13

- 7.1 Electromagnetic Compatibility (EMC)..... 13
 - 7.1.1 Background Radiation..... 13
 - 7.1.2 RF - United States - FCC..... 13
 - 7.1.3 RF - Canada - IC..... 13
- 7.2 Safety..... 13
 - 7.2.1 Safety Standards..... 13
 - 7.2.2 Required Safety Notifications..... 13
 - 7.2.3 Additional UL Requirements 13
 - 7.2.4 Future Agency Certification Plans..... 13
- 7.3 Environmental Impact..... 14

1 INTRODUCTION

1.1 Executive Summary

The US Smart Outlet is a radio controlled outlet that can apply or remove power to a device plugged into its receptacle. It also measures RMS power being utilized by the device being controlled.

The Outlet communicates wirelessly via 802.15.4 ZigBee SE 1.0 protocol, and responds to the ZigBee Smart Energy commands. It can be controlled via the Tendril Connect Platform through several portals (consumer, utility, support) for use in home automation and energy monitoring applications. The device is intended for indoor applications on UL rated 15A circuits.

1.2 About This Specification

This document describes the Outlet minimal requirements for purchase, such as performance, environmental specifications, and regulatory compliance requirements. This document is created and maintained by the Engineering and Operations Team.

1.3 Related Documents

- D10009-1xx Outlet Engineering Specification
- D10080-0xx Outlet Test Specification
- D10022-XXX Product Labeling Spec
- D10079-XXX Tendril Supplier Quality Policy

2 PRODUCT DESCRIPTION

2.1 Features

- 1) Smart Energy (SEP 1.1) certified via NTS or similar test house
 - a) AES 128 bit encryption across the HAN
 - b) Multiple ESI Support
 - c) Cluster Binding
 - d) ECC capability with Production Certificates
 - 2) Switches 120V, 15A UL rated device on or off via SEP DR Clusters and Tendril custom control commands. Device uses a latching SP relay that opens the hot side..
 - 3) Application Bootloader OTA upgrade capability of radio FW.
 - 4) Current, Voltage, and power measurement of attached loads, made available via the SEP Simple Metering Cluster
 - a) ID = Instantaneous Demand = Power ($V \cdot I \cdot PF$)
 - b) CSD = Current Summation Delivered = Energy (kWh)
 - c) Voltage = Special Tendril Cluster
 - d) Current = Special Tendril Cluster
 - 5) Certifications
 - a) UL 916 (Load Management Equipment)
 - b) Canadian UL Listed to Canadian Safety Standards (CAN/CSA 22.2)
 - c) FCC 15-B approval (US)
 - d) FCC ID and IC numbers on labels
 - e) Other International Certifications planned for future versions
- 1) Consumer safe, durable plastic housing for indoor use
 - 2) Push Button for:
 - a) Opt out of DR events or other OFF condition
 - b) Scanning for networks for non-ECC HANs
 - 3) Colored LEDs indicate status

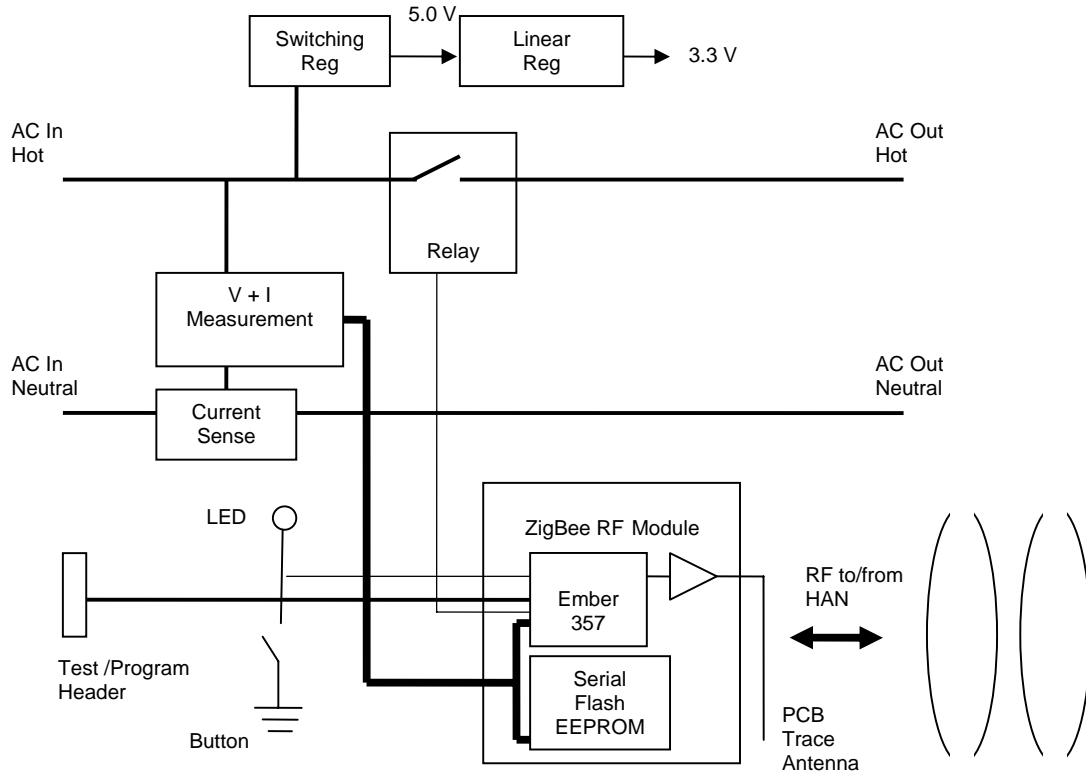
2.2 Electronic Hardware Description

PCBs contains:

- ZigBee Radio Module containing:
 - EM357 Radio SoC
 - 100mW RF Power Amp operating at 2.4GHz
 - 1MB external serial flash EEPROM
- 5V and 3.3V regulation
- Bi-color LED
- Switch for button
- Internal UART and test port connections sufficient to access the processor for programming at initial manufacture, and validate PCBA functionality
- 150VAC / 16A minimum rated latching relay with 5V coil
- Current and voltage monitoring circuitry for the connected load

Further power and radio specifications are listed in the Performance Section below.

2.2.1 Block Diagram



2.3 Relay

The device uses a latching relay, to retain the state through a device reset following an OTA. If a standard Normally Closed relay is used, and the device is reset while the relay is open, it will close momentarily. This is avoided if the relay is latched, and reset will not affect it.

3 Performance Specifications

3.1 Reliability

MCBF	Environment
Unit reliability = 500,000 POH (based on component analysis) Equates to a failure rate of 1.7% per year over the useful service life of 5 years.	Indoor Residential
Switching reliability = 100,000 MCBF operating both relays at 10 A resistive load	Indoor Residential

3.1.1 Reliability Testing

The reliability specification is tested at 120 VAC, 10A load while maintaining ZigBee radio communication.

- The radio shall not reset during device switches.
- ZigBee communication shall not be degraded by a consumer noticeable level during normal operation.

3.2 Power

3.2.1 Power Source

The unit is powered from a standard US 120 VAC \pm 10% source @ 50-60Hz. The unit operates over an input range of 100 to 150 VAC.

3.2.2 Power Consumption

AC Power Consumption is 0.6 W in quiescent state, ranging up to 1.5 W during RF transmission and all LEDs illuminated. 50ms surges of up to 0.5W additional power draw can occur when relay state changes are activated.

3.2.3 Noise Rejection

The unit meets *ANSI C37.90a Surge Withstand Capability* and other immunity requirements as specified in the agency requirements in Section 7.

Furthermore, no permanent damage to the unit will occur if noise on the AC power line is below the following specifications:

- Motor noise spikes of an extra 30V peak on top of the nominal AC line voltage and frequency

3.2.4 Power Cycling

The unit shall perform without failure through 3600 power cycles. This is based on a use case of 2 power cycles/day over 5 years.

Testing to validate this spec is done by cycling power for 5 seconds on, 30 seconds off, repeated 7200 cycles on a population of 4 units. This provides ~80% confidence this spec is met.

3.3 Sub-metering Accuracy

The unit measures and reports Voltage, Current, Instantaneous Power, and Energy as described in Section 2.1. Note that only Power and Energy are presently reported to TNOP. The accuracy is specified as follows:

	Current _{RMS}		Voltage _{RMS}	Instantaneous Demand	Current Summation Delivered
	Low	Normal			
Range	0-1.7 A _{RMS}	1.7-15 A _{RMS}	100-150 V _{RMS}	0.1 -3.0 kW	[0, 281 TWhr)
Average Accuracy	± 50 mA _{RMS}	± 3%	± 2%	± 4% or ± 6 W	Same as Inst Demand in %

The current shunt sense accuracy is stated as 3% or 50mA, whichever is higher. Similarly, Instantaneous Demand accuracy is either 4% or 6W, whichever is larger. Finally, the same % error determined for Instantaneous Demand carries forward into Current Summation Delivered.

Distortion of the voltage or current can adversely affect the accuracies declared above. Typically this is not an issue for line powered devices without an SCR or other switching components.

Tendrill does not have the equipment or procedure to calibrate units.

3.4 Radio

3.4.1 HAN Radio Specifications

The product conforms to the Zigbee (IEEE 802.15.4 RF) specification and utilizes the ZigBee Smart Energy profile with additional Tendrill functionality. The unit utilizes a fully tested and certified transceiver module with the following specifications:

- Indoor Range: 300 ft
- Outdoor Line of Sight: 1000 ft
- Tx Power: +20dBm (100mW)
- Rx Sensitivity: -102 dBm
- RF Data Rate: 250 kbps

3.4.2 Channel Tx Power

In order to comply with US FCC Requirements as stated in OET Bulletin No 63, October 1993, the upper channels are attenuated relative to other channels as follows:

	Typical Tx Power	
	Level	Power (dBm)
Channel 11 (2405 MHz) – Channel 23 (2465 MHz)	3	20
Channel 25 (2475 MHz)	-3	14
Channel 26 (2480 MHz)	-14	4

4 Physical Specifications

4.1 Dimensions

Specification	Value (to be updated)
Length	108 mm (4.5 in)
Width	64 mm (2.75 in)
Depth	35 mm (1.5 in)
Unit Weight	0.22 kg (.5 lbs)
Shipping Weight (packaged)	0.33 kg (.8 lbs)
Packaging Dimensions	228.6 mm (9.0 in) x 177.8 mm (7.0 in) x 69.9 mm (2.75 in)
Orientation	Operates in any orientation

4.2 Appearance

The unit appears roughly as shown.



4.3 LEDs

The unit contains 1 bicolor LED.

4.4 Button

A large button on the front of the unit is used to provide manual input to the processor. It provides tactile feedback upon closing the switch. It activates with < 1lb pressure and is warranted for 5000 presses.

4.5 Device Labeling

Please refer to the *Product Labeling Specification D10022-001* for the general device labeling requirements. This section covers device specific details over and above that specification.

4.5.1 Housing and Agency Label

For this product, the Housing and Agency labels can be split into two labels or applied as one label (on the back of the unit) as long as clear readability of the contents are maintained. EUI-64, Installation Code, Agency marks, FCC ID and IC numbers must be clearly visible.

4.5.1.1 Company and Product Name

This product should display manufacturer's company and model name on the label instead of "Tendril Networks, Inc." specified in the *Product Labeling Spec*.

4.5.1.2 Tendril Logo

Instead of Tendril Logo specified in *Product Labeling Spec*, the following logo should be placed on any one of labels.



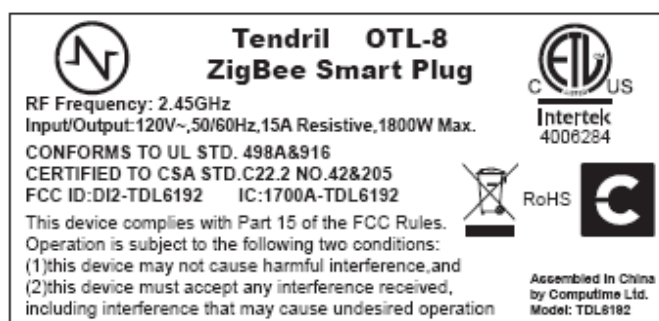
This logo identifies the product as Tendril Connect certified.

4.5.1.3 Model Number

Tendril model number for this product is defined as **TDL6192**

4.5.1.4 Label Example

Below is a sample of contents in a single label case. Please refer to the Product Labeling Spec for two labels.



4.6 ESD Failure Level Limits

Failure Type	Equipment	Failure Level	Allowable Errors
Hardware	Office	1 to 8 kV	No operator intervention (recoverable error allowed)
Hardware	Office	Up to 15 kV	No component damage - operator intervention allowed

The unit is tested in its normal usage state, plugged into a grounded wall outlet.

Ref Document: 89/336/EEC, Directive Concerning Electromagnetic Compatibility (EMC)

Test Specification: EN61000-4-2. Refer to Section 7 for further immunity specifications.

ESD protection and warranty are voided if the unit is opened by personnel other than Tendril or the supplier employees.

4.7 Environmental Specifications

4.7.1 Altitude

Altitude	Value
Operating Range	-500 feet to 15,000 feet
Non-operating Range	-500 feet to 50,000 feet

4.7.2 Temperature

Temperature	Value
Operating Range	0° C to 40° C
Operating Gradient	Maximum of 15° C per 60 minutes
Nonoperating Range	-40° C to 65° C
Nonoperating Gradient	Maximum of 20° C per 60 minutes

4.7.3 Humidity

Humidity	Value
Operating Range	10% to 90% (non-condensing)
Operating Gradient	Maximum of 20% per 60 minutes
Nonoperating Range	5% to 95% (non condensing)
Nonoperating Gradient	Maximum of 20% per 60 minutes

4.7.4 Actual Environmental Test Corners

Operational

0°C @ low absolute humidity
 0°C @ 90%RH
 40°C @ 20%RH
 40°C @ 70%RH
 32°C @ 90%RH

Non-operational Storage

+20°C at 10% RH
 +65°C at 5% RH
 +32°C at 95% RH
 +20°C at 20%
 -40°C

4.8 Shock and Vibration Specifications

4.8.1 Transportation Vibration

This test exposes the unit under test, packed for shipment to transportation vibration for approximately one hour.

- The test shall be done to the same units under test, using the same packaging, as the units used for Transportation Drop Test and shall be conducted PRIOR TO the Transportation Drop Test. The units under test, packaged in their intended packaging shall meet the requirements identified in Vibration Testing in the International Safe Transit Test Procedure 1A.

4.8.2 Transportation Drop

This test shall follow Transportation Vibration and shall be conducted as described in Shock Testing in the International Safe Transit Association test procedure 1A.

- The device shall be in its intended final packaging.
- The device shall be exposed to ten drops to hard floor in accordance with the above referenced International Safe Transit Association standard.

4.8.3 Non-Operational Shock

The product shall pass a test conducted as described in ICE 60068-2-27 REV 1987 based on the following conditions:

1. The device shall not be operating and shall be without packaging.
2. The device shall be rigidly mounted to a test fixture and at a reference point for the control accelerometer shall be attached to the test fixture.
3. Half sine pulse applied 3 times in each direction, for each of the 3 mutually perpendicular axes and a total of 18 shocks.
4. Peak acceleration shall be 15 g (150 m/s²) with a duration of 11 ms with a corresponding velocity change of 1.0 m/s.
5. Post test, an accuracy performance check shall be performed to verify function.

Specification	Value
Pulse Shape	Half sine wave
Peak Acceleration	15 G (150 m/s ²)
Duration	11 ms
Application	3 pulses per side for 3 sides

4.8.4 Non-Operational Vibration

The product shall pass a test conducted as described in ICE 60068-2-6 REV 1987 based on the following conditions:

1. The device shall not be operating and shall be without packaging.
2. The device shall be rigidly mounted to a test fixture and at reference point for the control accelerometer that shall be attached to the test fixture.
3. The test shall be run over a frequency range of 30 to 350 Hz with a sweep time of one octave per minute at 5 m/s² (0.5 g) along each of three mutually perpendicular axes.
4. The sweep duration shall be 30 minutes also each axis.
5. Post test an accuracy performance check shall be performed to verify function.

Specification	Value
Frequency Range	30 - 350 Hz, sweep of one octave/minute
Acceleration Level	0.5 G (5 m/s ²) along each axis
Application	1.5 hour total test time. 30 minutes along each axis

4.8.5 Operational Random Vibration

The product shall pass a test conducted as described below based on the following conditions:

1. The device shall be operating and shall be without packaging
2. The device shall be rigidly mounted to a test fixture and at a reference point for the control accelerometer that shall be attached to the test fixture
3. The test shall be run over a frequency range of vibration as described below.
4. Concurrent with vibration and post test, an accuracy of performance check shall be performed to verify function.

Random Vibration

Specification	Value
Frequency Range	1-400 Hz
Acceleration Level	1.06 G _{rms}
Application	3 sides - 20 minutes per side

PSD Spectrum

Frequency	PSD (g ² /Hz)
1 Hz	0.0003
3 Hz	0.0055
12-100 Hz	0.01
400 Hz	0.000003

5 Installation

5.1 Location

The unit is designed for indoor use, plugged into a standard wall outlet, covering both receptacles, or into an appropriately grounded extension cord. The package is designed for In-home installation. The product is not intended to operate exposed to the elements.

5.2 Maintenance / Service

The device requires no user maintenance. Users should observe the requirement that the electronics within the device be kept enclosed and sheltered from the elements. The firmware within the device will be maintained via the Tendril OTA or SE1.1 OTA process.

The device is not user serviceable. Units that are defective or not repairable via the OTA process require an RMA process. Details on the RMA process are found in the Master Supply Agreement.

6 Manufacturing / Test Specifications

6.1 Manufacturing Process

The units are manufactured at a UL certified facility that has been approved by Tendril. Refer to *D10079-XXX Tendril Supplier Quality Policy* for supplier requirements.

EC approval is specified in the Long Form Agreement.

A database containing the following items per device is maintained and available to Tendril:

1. Serial Number
2. EUI-64
3. Installation Code
4. ECC Certificate (or a cross reference to a secure list)
5. Manufacture Date
6. Pass/Fail results for the parameters listed below, with parametrics as available

6.2 Minimum Testing Requirements

The Manufacturing Test Requirements document shall be provided by the supplier and approved by Tendril. That That testing may be a superset of this minimal requirement list stated here:

1. Program the radio processor and validate success
2. Validate 2 way RF communication
3. Verify both relays open and close when commanded by processor
4. Validate metering capability of both channels
5. Validate button and LEDs operate correctly via processor
6. Validate ECC Certificate and any configuration tokens are set

7 Agency Requirements

7.1 Electromagnetic Compatibility (EMC)

7.1.1 Background Radiation

The unit is certified as passing EMC requirements covered under the UL 916 spec.
The unit is certified under FCC part 15 Class B. External labeling shall indicate certification.

7.1.2 RF - United States - FCC

The unit meets FCC Part 15 Subpart C for intentional radiators. The radio module FCC ID of QPU3020 extends to device. External labeling shall indicate certification.

7.1.3 RF - Canada - IC

The radio module used internally is IC Certified. The radio module IC: 4523A-SN2030 extends to device. External labeling shall indicate certification.

7.2 Safety

7.2.1 Safety Standards

The unit displays certification to the following specifications:

- UL 498 and UL 916 (Load Management Equipment) or ETL equivalent
- CAN/CSA 22.2: Canadian UL Listed to Canadian Safety Standards

7.2.2 Required Safety Notifications

Labeling - The label on the units need to be made of a UL or ETL Recognized material by a UL or ETL Recognized label manufacturer and be suitable for the surface on which it is placed. The label must contain the following minimal information:

- Manufacturer's name
- Electrical ratings
- Model number

7.2.3 Additional UL Requirements

- All components are UL Certified
- A/C adapters are UL Listed, Class 2, UL flammability rating of the plastics as low as 94 HB
- PCBs are made of a UL Recognized material and manufactured by a UL Recognized supplier
- PCB temperature rating is rated 105 degrees C minimum

7.2.4 Future Agency Certification Plans

As the device is modified to be suitable for international shipment, the following agency certifications will be required and displayed via labeling:

- a) CE (Europe)
- b) C-TICK (Australia and New Zealand)

7.3 Environmental Impact

Meets Waste Electrical and Electronic Equipment Directive (**WEEE** Directive)
Meets Restriction of Hazardous Substances Directive (**RoHS** Compliant)

7.4 Canada/FCC Statement:

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct

- The interference by one or more of the following measures:

Reorient or relocate the receiving antenna.

Increase the separation between the equipment and receiver.

Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.

Consult the dealer or an experienced radio/TV technician for help

- This device complies with Part 15 of FCC Rules.

Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and

2. This device must accept any interference received, including interference that may cause undesired operation.

Note: "Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment."