XIDAS IOT

VP3 Vibration Perpetual Power Pod

Technical Brief

With significant funding from the US National Science Foundation, Xidas IoT introduces the everlasting IoT battery solution.

This perpetual power pod integrates energy harvesting technology that captures the energy from small vibrations in the environment (such as industrial machinery) and converts it into electrical power that trickle charges a specialized on-board battery. Through disruptive electromagnetic transducer design, proprietary analog boost circuitry, and specialized battery integration, the VP3 provides sensors with up to 10 years of lifetime. Leveraging decades of 3D manufacturing research, Xidas delivers a cost-effective solution to the IoT market's biggest issue: **battery life**.

Up to 10-year lifetime for sensors*

Up to 10 mW of direct battery power generation from vibrations with less than 1 g of acceleration

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Small profile (54 mm diameter x 42 mm height)

Power handling accommodates all wireless technologies

- Low-current devices (BLE, ZigBee, LoRa, Sigfox, NB-IoT)
- High-current operation (WiFi, Cellular)

Plug-and-Play

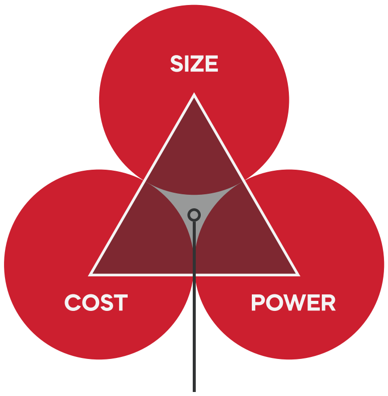
- Output easily integrated with existing equipment
- No conditioning circuitry required
- Seamless charging/discharging

Ruggedized design

- Sturdy, waterproof IP67 enclosure
- –20 to +85°C temperature range

Power, Size, and Cost Value Triangle

Wireless sensors have unique power signatures that put a strain on regular batteries. With the increase in intelligent sensing, sensors can capture and analyze machine signatures, monitor for alarms and environment, be network aware and transmit to customers networks. This results in power requirements ranging from small current drains when monitoring to large pulses when transmitting, dropping battery output voltages to unusable levels in undetermined times and considerably shortening standard battery lifecycles. Current battery-driven wireless sensors only have lifetimes of 1 to 2 years, resulting in expensive maintenance costs associated with replacement.



Estimated cost of one battery replacement

● = Time
● = Cost

● (Time)	Identify & locate	30 (minutes)
● (Time)	Paperwork & logistics	30 (minutes)
● (Time)	Pull repair stock items	15 (minutes)
● (Time)	Traveling to & locating devices	30 (minutes)
● (Time)	Power module change	5 (minutes)
● (Time)	Return & verify operation	40 (minutes)
● (Time)	Disposal of old batteries	15 (minutes)
● (Time)	Total time in minutes	165 (minutes)
● (Cost)	Hourly labor rate	$85
● (Cost)	**Labor cost**	**$233.75**
● (Cost)	Consumables / other costs	$15.00
● (Cost)	Inventory cost of spares	$45.00
	Total	**$293**
	Cost over 10 years (two-year battery life cycle)	**$1,465**

Vibration energy harvesting solutions have been available for over a decade. However, they have not been widely accepted within the IoT community because the majority of machines from which energy can be harvested vibrate at very low frequencies and at very low accelerations. To properly power IoT sensors, these energy harvesters need to provide at least 1 mW of power. Traditional electromechanical solutions can harvest this energy, but have been too large and extremely expensive (7 to 10x the cost of wireless sensors). The smaller, more cost-effective piezoelectric energy harvesters, unfortunately, have not been able to generate enough power from the frequencies and g's of wireless IoT applications.

Xidas perpetual power pod with integrated energy harvesting throws all these limitations out the window. Our **"value triangle"** makes the product an ideal replacement to standard batteries for IOT wireless sensors—**high power output combined with small size combined with affordability**. We've done the engineering for you to support your sensors for decades. All you have to do is provide a natural vibration source. The Xidas perpetual power pod can even run for weeks when the energy harvesting source is removed (i.e. train/truck/ship is parked, or machine being monitored shuts down due to maintenance or power outages).

How it works

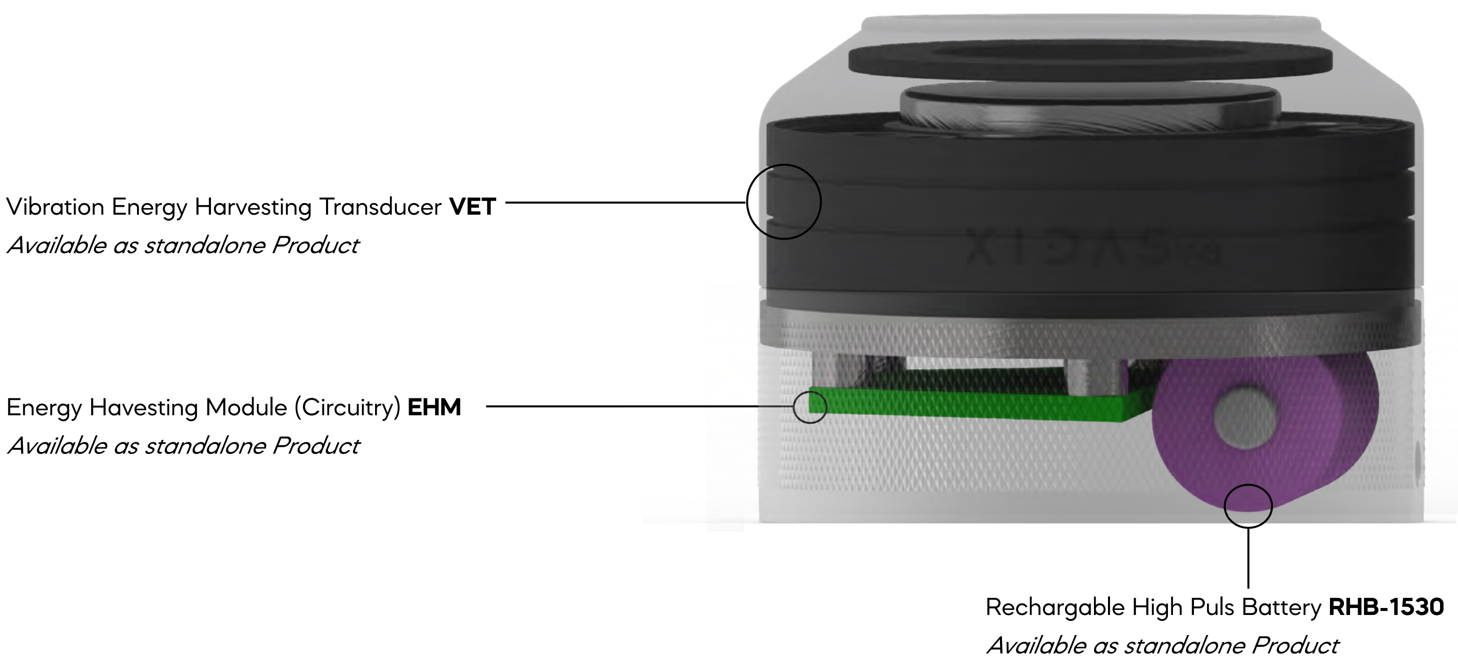
The energy harvesting transducer inside the VP3 is designed to generate power from a specific resonant frequency. Xidas offers a range of VP3 models that are tuned for 20 Hz (VP3-20), 30 Hz (VP3-30), 50 Hz, (VP3-50), and 60 Hz (VP3-60). It is important to understand what is the common resonant frequency of the vibrating source you will be mounting on - this will determine which VP3 model to purchase. The vibrating source does not need to consistently vibrate at this resonant frequency. The VP3 has an on-board battery that will continue to power the wireless sensor even when the appropriate vibration source is not available. However, this battery will only recharge when the source begins vibrating at the target resonant frequency again.

The VP3 is designed to be mounted on any vibrating surface within a few feet of the wireless sensor it powers. Inside, our proprietary energy harvesting transducer generates electrical current from low vibration profiles and trickle charges an on-board battery via our analog boost circuitry. This on-board battery allows the device to power a sensor even when vibration energy is not available. From the unit, power is delivered to the wireless sensor via a 5-pin, IP67 M12 Connector Cable cable. Wireless sensors must be modified to accept this cable connection.

The VP3's specialized high-pulse current lithium battery (RHB-1530 availabe as standalone product) can accommodate all wireless technologies, from Low-current devices (BLE, ZigBee, LoRa, Sigfox, NB-IoT) to high-current and high-pulse operations (WiFi, Cellular). The VP3 offers several output options that make the battery truly plug-and-play. For instance, Pin 4 provides a regulated output voltage with no conditioning so your sensor can plug right into it just like a normal battery and you are ready to go! For applications with higher current demands (>150 mA peaks), Pin 1 gives you access to the system voltage, going up to 4.1 V. Xidas also provides a line to monitor the amount of current going into the battery (being harvested) as well as going out. You will always know the status of the battery life.

Integration into Existing and New Wireless

Xidas also offers the vibration energy harvesting transducer (VET), the energy harvesting analog boost circuitry (EHM), and the rechargeable high-pulse battery (RHB-1530), as standalone products for direct integration into your wireless sensor. We encourage sensor companies to work with us to integrate these building blocks into your sensors, hence increasing the life and value of your solutions without adding significant cost. Xidas also provides engineering services that can aid in the integration or development of your energy harvesting wireless sensor.



Electical Specifications

Harvesting Power:	0.5 to 10mW
System Voltage Output	4.1 to 3.0VDC @ 750mA max
Regulated Voltage Output	1.8 or 3.3VDC @150mA max
Energy Storage	Wide-Temperature High Pulse Battery
M12-5P Cable	Rated Voltage 300V, Rated Current 1A, IP67 Rated

Mechanical Specifications

Outline Dimensions	56mm Dia x 42mm Height
1 Mounting Hole	¼-28 UNF, 6.35mm Deep
Weight	6.3 ounce (nominal), 180 gram
Resonant Frequency	20 to 70Hz
Vibration Label	.05g to 1g of acceleration
Shock Limit	50g's

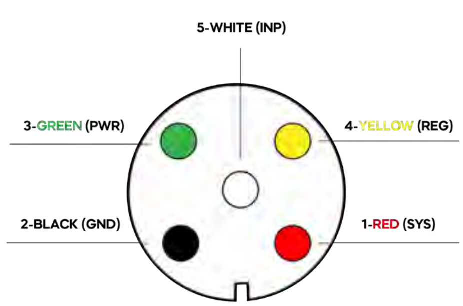
Material Information

- Enclosure Material: Aluminum 6061 Anodized RoHS Compliant
- UL Certified Battery
- PCB board UL Recognized
- M12-5P IP67 Rated Cable

Cable Information

Cable: 5 Pins M12 Connector Cable, UL listed wires, PVC,

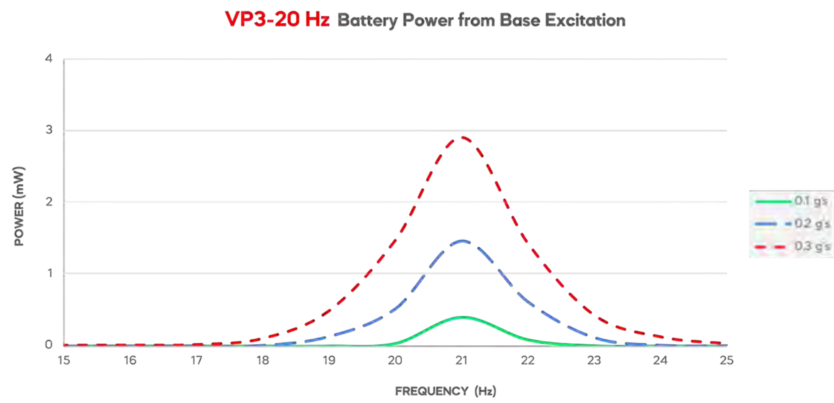
Number	Color	Deg	Description
1	Red	SYS	System output voltage (4.1 to 3.0V @750mA max)
2	Black	GND	Ground Return
3	Green	PWR	Charging power monitor (0.1 Ω shunt resistor to ground)
4	Yellow	REG	Regulated output voltage, factory set (1.8 or 3.3V @ 150mA)
5	White	INP	5VDC @50mA charging input voltage (e.g,, from USB)

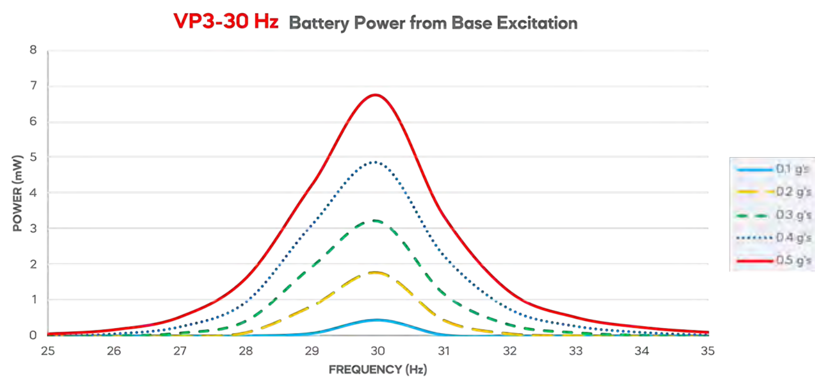


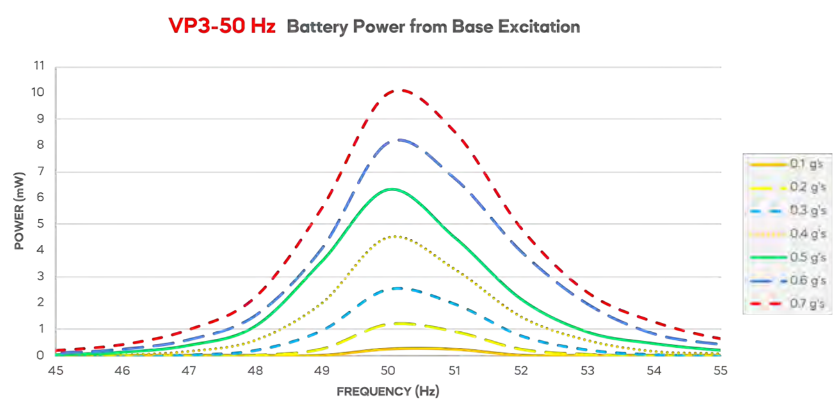
PIN ASSIGNMENT M12 SOCKET FEMALE SIDE

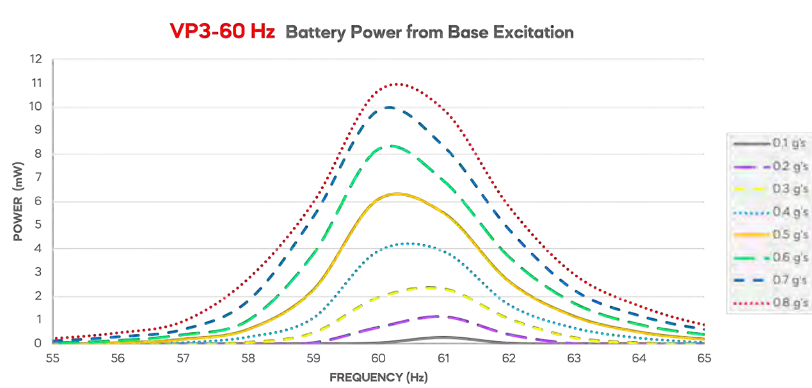
Energy Harvesting Power Output

If the average power consumption of the sensor is less thanthe energy harvesting power output at the desired frequency and acceleration, a 10-year lifetime can be achieved.







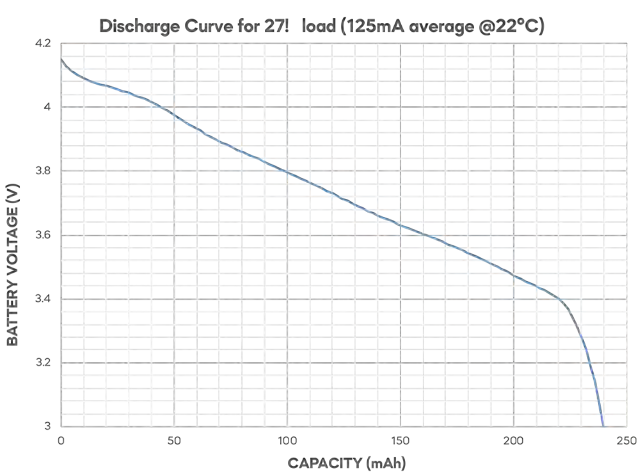


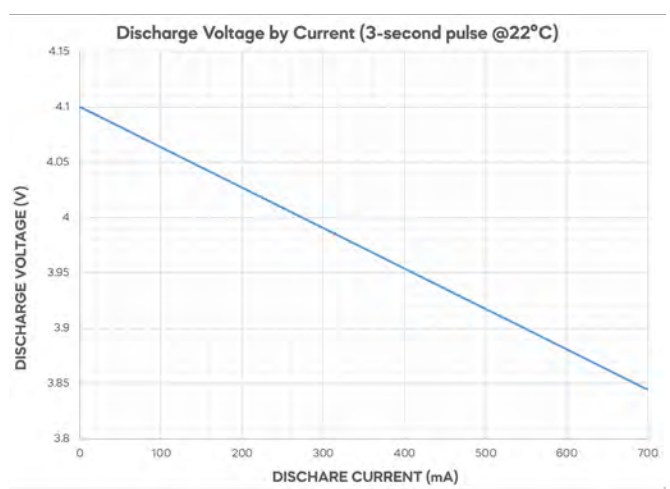
Battery Information

- Xidas PN 86000000, Approved to UL1642, File Number MH61680 Vol 1.

- Material Safety Data Sheet available in www.xidasiot.com/MSDS

System	Hybrid Pulse Capcitor
Maximum Charge Voltage	4.1V
Discharge End Voltae	3.0V
Maximum Capacity	240mAh
Nominal Discharge Current	125 mA
Maximum Continous Discharge Current	750 mA
Pulse Current Capability	3000 mA
Nominal Charge Voltage	50 mA
Temperature Range	-40 C to +85 C
Cell Impedance @ 1 kHz,Rt	max 120m Ω





Ordering Information

Part Number	Description
10-300100	VP3-30 Hz
10-300200	VP3-60 Hz
10-300300	VP3-50 Hz
10-300400	VP3-20 Hz

Environmental Specification

- Lead-free (ROHS) compliant
- Operating Temperature Range: -20 to +85 C
- Storage Temperature: -40 to +85 C
- Protection: Anodized & Power coated

Saftey

This product, when used under reasonable conditions and in accordance with the directions for use, should not present a health hazard as it is equipped with UL listed battery, UL Recognized PCB. Do not expose the product to open flame.

Handling & Storage

Do not disassemble the product.
Keep the products in its original packaging until they are used.
Do not incinerate the product.
Do not store near heat or flame.
Store in original packaging.

Transport Information

With regard to transport, the following regulations are cited and considered:
-UN No. 3091 Section II
-Lithium battery contained in equipment

Warrenty

Xidas warrants that Xidas, Inc.-branded products will be free from defects in materials and workmanship for a period of 90 days from the date of delivery. Xidas, Inc. will have no warranty obligation with respect to Products subjected to tampering, abuse, misuse, negligence or accident. If any hardware component of any Product fails to conform to the warranty in this Section, Xidas, Inc. shall repair or replace non-conforming Products with conforming Products or Products having substantially identical form, fit, and function and deliver the repaired or replacement Product to the customer within a reasonable period after Xidas, Inc. receives from Customer (i) notice of such non-conformance, and (ii) the non-conforming Product provided.

Target Applications

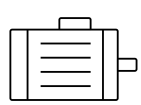
Eliminating the need of wiring and cabling for sensors does wonders. You can now throw away high installation costs and add monitoring capabilities to places and things you couldn't before. No matter the sensing application, the biggest problem with wireless sensors is power... batteries die. Replacing several batteries every few years can be a huge maintenance headache that prohibits the implementation of these next generation systems. Not anymore with Xidas IoT's battery solutions.

Power wireless sensors for machine condition monitoring (predictive maintenance)

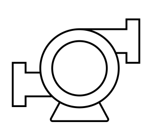
Industrial plants no longer have to monitor and repair their machinery through a labor-intensive preventative maintenance approach, which is costly. This is when maintenance workers routinely diagnose and repair the assets on a scheduled basis. Preventative maintenance expenses include the cost of routine service parts, cost of routine service labor, production loss due to frequent equipment downtime, cost of managing preventative maintenance programs, and cost of determining effectiveness of routine maintenance.

Predictive maintenance uses sensors that monitor and transmit plant machinery condition (data) to the cloud where it is analyzed utilizing machine learning to predict maintenance needs. In this approach, the health and condition of motors, pumps, blowers, fans, compressors, conveyor belts, gearboxes, and other machinery is consistently examined and supervised to ensure operation runs properly. Bearing defects, misalignments, imbalances, looseness, and other deficiencies that lead to failures can be detected.

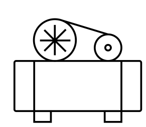
Predictive maintenance can reduce the time required to plan maintenance by 20–50%, increase equipment uptime and availability by 10–20%, and reduce overall maintenance costs by 5–10%. The VP3 is perfect for powering the sensors used for industrial asset condition monitoring; efficiently harvesting the vibration from these machines to power the mounted wireless sensors.



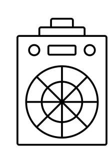
MOTORS



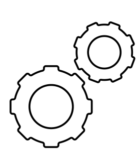
PUMPS



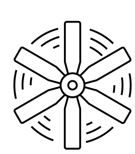
COMPRESSORS



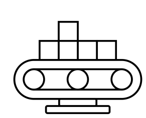
CHILLERS



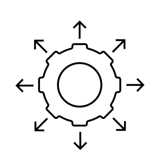
GEARBOXES



FANS & BLOWERS



CONVEYER BELTS



AUTOMATION

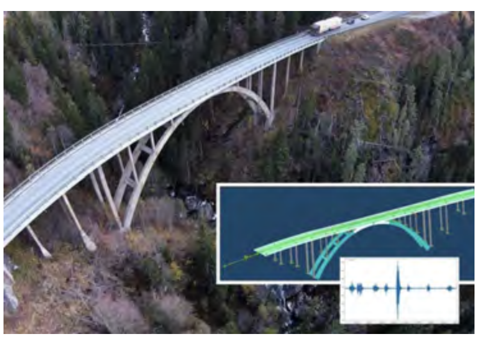
Power wireless sensors for train condition monitoring

Train maintenance still rely on visual inspections and preventive measures, which make it hard to identify faults in time and satisfy maintenance needs. Scheduled preventive maintenance and parts replacement are based on running time and distance, and is often combined with infrequent and simple visual inspections. This method of maintenance is not always able to identify and detect emerging faults, which result in breakdowns between planned maintenance occasions.

Another issue is so called "no fault found" situations. This is when maintenance follows a passenger’s complaints about poor ride comfort and trys to re-produce the fault. The maintenance crews are not guaranteed to identify the cause of the issue, due to lack of available data and details from initial reports. Often, the wrong components may end up being serviced.

Wireless sensors can be used for wheel, axle box, and gear box condition monitoring on a train. Frequent data collection and analysis of these assets can provide insight on sub-optimal performance, detect potential malfunctions, and ultimately avoid bumpy rides for passengers. The VP3's industrial design makes it ideal to perpetually power sensors used to monitor train components!

Power wireless sensors on other vibrating surfaces



The potential and use cases for IoT wireless sensors are endless. If there is a vibrating source nearby, then Xidas IoT’s Vibration Perpetual Power Pod provides the sensor with an extremely long lifetime. This completely eliminates the hassle of replacing the battery every few years. Imagine powering a sensor from the vibrations of a bridge, an HVAC unit, a truck/vehicle, etc. The possibilities are endless.

Trucks

GPS fleet management, including all of the sensors

Construction Equipment

Wind Turbines

Combine early warning, security and responses like shutouts/ shutoffs in new turbine designs and ability to optimize performance and to better predict maintenance needs.

Pipelines

Oil/gas pipeline monitoring has a major importance on safe and effective logistics of oil and gas products.

Pumpjacks

Mechanically lift liquid out of the well if not enough bottom hole pressure exists for the liquid to flow all the way to the surface.