EH300/301 EPAD® ENERGY HARVESTING™ MODULES

GENERAL DESCRIPTION

EH300/EH301 Series EPAD® Energy Harvesting™ Modules can accept energy from many types of electrical energy sources and store this energy to power conventional 3.3V and 5.0V electrical circuits and systems. EH300/EH301 Series modules are completely self-powered and always in the active mode. They are intended for low power intermittent duty cycle sampled data or condition-based monitoring/ extreme lifespan applications. These modules can accept instantaneous input voltages ranging from 0.0V to +/-500V AC or DC, and input currents from 200nA to 400mA from energy harvesting sources that produce electrical energy in either a steady or an intermittent and irregular manner with varying source impedances. EH300/EH301 Series modules condition the stored energy to provide power at output voltage and current levels that are within the limits of a particular electronic system power supply specifications. For example, 1.8V and 3.6V is a useful voltage range for many types of IC circuits, such as microprocessors.

EH300/EH301 Series modules are designed to continuously and actively operate to capture, accumulate, and conserve energy from an external energy source. Each individual EH300/EH301 Series module is set to operate between two supply voltage thresholds, +V_low DC and +V_high DC, corresponding to the minimum (V_L) and maximum (V_H) supply voltage values for the intended application. When an energy source starts to inject energy into the inputs of an EH300/EH301 Series module in the form of electrical charge impulses, these charge packets are collected, accumulated and stored onto an internal storage capacitor bank. For most common energy harvesting applications, the electrical energy charge packets arrives in the form of input voltage spikes that are uncontrolled and unpredictable. Often these cover a wide range of voltages, currents and timing waveforms. EH300/EH301 Series modules are designed to accommodate such conditions with exceptional efficiency and effectiveness. As an example, a EH300 module can cycle within 4 minutes at an average input current of 10μA and within 40 minutes at an average input current of just 1.0μA.

ORDERING INFORMATION

Part Number	Description
EH300 EH300A	4.6 mJ Module / 1.8V to 3.6V operation 30 mJ Module / 1.8V to 3.6V operation
EH301 EH301A	8.3 mJ Module / 3.1V to 5.2V operation 55 mJ Module / 3.1V to 5.2V operation
EHJ1C EHJ2C	6 inch cable / J1connector (Input) 6 inch cable / J2 connector (Output)

Note: EH300A and EH301A are high energy output versions

BENEFITS

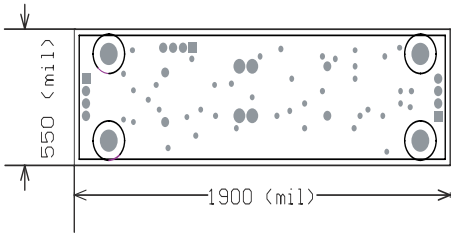
- Eliminates manual and elaborate system trimming procedures
- Remote controlled automated trimming
- In-System Programming capability
- No external components
- No internal clocking noise source

APPLICATIONS

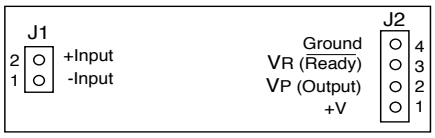
- Sensor interface circuits
- Transducer biasing circuits
- Capacitive and charge integration circuits
- Biochemical probe interface
- Signal conditioning
- Portable instruments

MECHANICAL SPECIFICATIONS

- Outline Dimensions:
  W x L x H : 0.55 in. x 2.00 in. x 0.70 in.
- 4 Mounting Holes: 0.085 in. diameter
- Weight: 0.5 ounce (14 grams) nominal



Top View



Socket Adapter Cable:
J1: Hirose Socket, 2 Position P/N : DF13-2S
J2: Hirose Socket, 4 Position P/N : DF13-4S

FUNCTIONAL DESCRIPTION

The EH300/EH301 Series module's voltage on the onboard storage capacitor bank is +V, which is also the positive supply voltage switched to power the output power load. Initially, +V voltage on an EH300/EH301 Series module starts at 0.0V. During the initial charge period, +V starts charging from 0.0V. The module's internal circuit monitors and detects this +V voltage. When +V reaches V_H, the module output (V_P) is enabled and turned to the ON state and is then able to supply power to a power load, such as a microprocessor and/or a sensor circuit. The amount of useful energy available is a function of the capacity of the storage capacitor bank. Meanwhile, an EH300/EH301 Series module continues to accumulate any energy generated by external energy sources. If external energy input availability is high, output V_P remains in an ON state continuously, until such time that external energy availability is lower than the power demand required by the power load. As external energy input exceeds power loading, +V increases until internal voltage clamp circuits limit it to a maximum clamp voltage.

During normal operation, as power is drawn from an EH300/EH301 Series module, +V decreases in voltage. When +V reaches V_L, output V_P switches to an OFF state and stops supplying any further power to the power load. With built-in hysteresis circuits within the module, V_P now remains in the OFF state, even when the external energy source starts charging the capacitor bank again by importing fresh new impulses of electrical energy. Once V_H level is reached again, output V_P is then turned to the ON state again. Hence +V voltage cycles between V_H to V_L voltage levels and then to the OFF state. When in the ON state, V_P can supply up to 1A of current for a limited time period as determined by the stored useful energy and the energy demand by the power load. An optional input/ouput pin V_R functions as V_P on/off control (external input through 1KΩ) or as READY logical control (output) signal preceeding output V_P switching.

Input energy charging times t1 and t2 are limited by input energy available minus energy loss by an EH300/EH301 Series module. The energy output time period t3 is determined by the rate of energy used by the power load as a function of energy stored. Low input energy hold time t4 is typically many orders of magnitude greater than the sum of t1, t2 and t3.

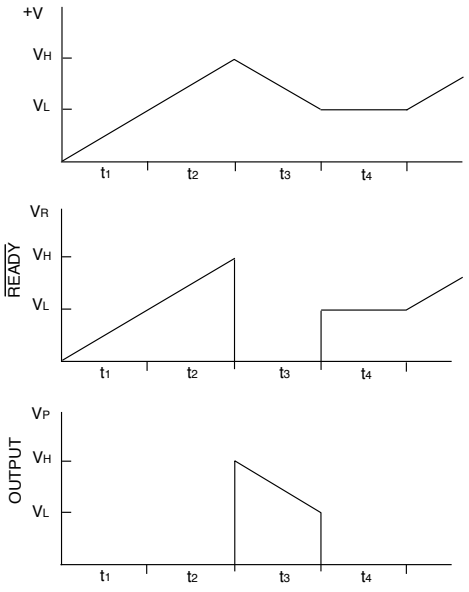
ENVIRONMENTAL SPECIFICATIONS

- Leadfree (ROHS) compliant
- Operating Temperature Range: 0 to 70° C
- Max. Average Operating Temperature : 50° C
- Storage Temperature: -40 to +85° C
- Humidity: To 90% (no condensation)
- Protection: Conformal and Epoxy coated

INITIAL SETUP & CALIBRATION

EH300/EH301 Series modules are setup and calibrated at the factory to standard specifications and settings. No user setup is required. Optional user control signal and connection to external capacitor or battery storage banks are available at the output port. All EH300/EH301 Series modules are shipped ready to use.

EH300/EH301 Waveforms



ABSOLUTE MAXIMUM and MINIMUM RATINGS

Max. instantaneous input voltage	+/- 500V
Max. instantaneous input current	400mA
Max. input/output power	500 mW
Operating temperature range	0°C to +70°C
Min. input	0.0V@1nA
Internal voltage clamp	7.0V@10mA
Max. output current	1A

CAUTION: ESD Sensitive Device. Use static control procedures in ESD controlled environment.

OPERATING ELECTRICAL CHARACTERISTICS

T_A = 25°C, V_{IN} = 4.0V unless otherwise specified

Parameter	Symbol	EH300			EH300A			Unit	Test Conditions
		Min	Typ	Max	Min	Typ	Max		
Output Low Level	V_L		1.9			1.9		V	
Output High Level	V_H		3.5			3.5		V	
Charging Input	V_{in}	4.0/200			4.0/200			V@nA	
Power Dissipation	P_D		0.4	0.8		1	2	μW	
Useful Energy Output	E		4.6			30		mJ	1 cycle
Output On-time Rating	t * I		68/25			75/150		msec@mA	1 cycle
V_P Output Resistance	R_{VP}		0.15			0.15		Ω	V_P = 3.5V
V_R Output Sink Current	I_{Rsink}		2.5			2.5		mA	V_P = 3.5V, V_R = 3.5V
V_R Output Source Current	$I_{Rsource}$		-1.0			-1.0		mA	V_P = 3.5V, V_R = 0.0V
Output Load	R_{load}	3.5			3.5			Ω	I_{out} = 1A
Output Current	I_{out}			1			1	A	R_{load} = 3.5Ω

T_A = 25°C, V_{IN} = 6.0V unless otherwise specified

Parameter	Symbol	EH301			EH301A			Unit	Test Conditions
		Min	Typ	Max	Min	Typ	Max		
Output Low Level	V_L		3.1			3.1		V	
Output High Level	V_H		5.2			5.2		V	
Charging Input	V_{in}	6.0/300			6.0/300			V@nA	
Power Dissipation	P_D		0.9	1.8		1.5	3	μW	
Useful Energy Output	E		3.9			55		mJ	1 cycle
Output On-time Rating	t * I		80/25			885/150		msec@mA	1 cycle
V_P Output Resistance	R_{VP}		0.1			0.1		Ω	V_P = 5.0V
V_R Output Sink Current	I_{Rsink}		5			5		mA	V_P = 5.0V, V_R = 5.0V
V_R Output Source Current	$I_{Rsource}$		-2			-2		mA	V_P = 5.0V, V_R = 0.0V
Output Load	R_{load}	5			5			Ω	I_{out} = 1A
Output Current	I_{out}			1			1	A	R_{load} = 5.0Ω