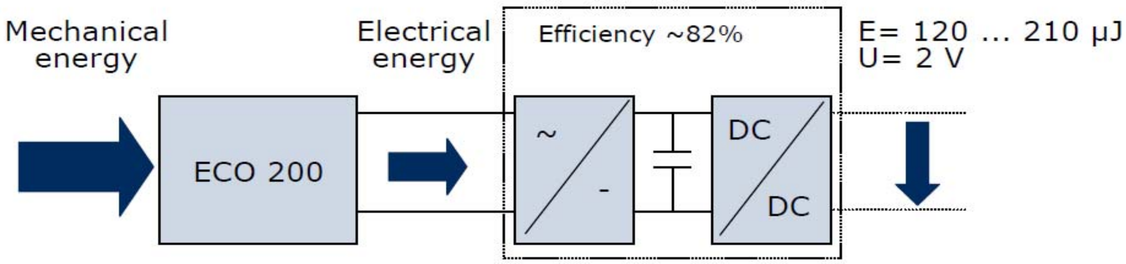
PTM 330 Alternative Power

INTENTION OF THIS APPLICATION NOTE

Not always is required to use the PTM 330 (Dolphin-based EnOcean transmitter) together with the dedicated EnOcean ECO 200 electro-dynamical energy harvester. This Appnote refers to PTM 330 powered by alternative energy source like e.g. battery.

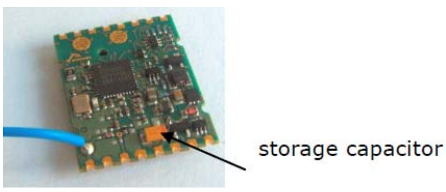
According to the user manual, the PTM 330 needs a short energy pulse typically supplied by the ECO 200 energy generator (typ. 200 µWs electrical energy output/actuation) applied between its AC1 and AC2 power inputs, to transmit a complete radio telegram. The PTM 330 can be alternatively powered by battery respectively another adequate alternative energy source if needed, however some requirements must be therefore fulfilled.



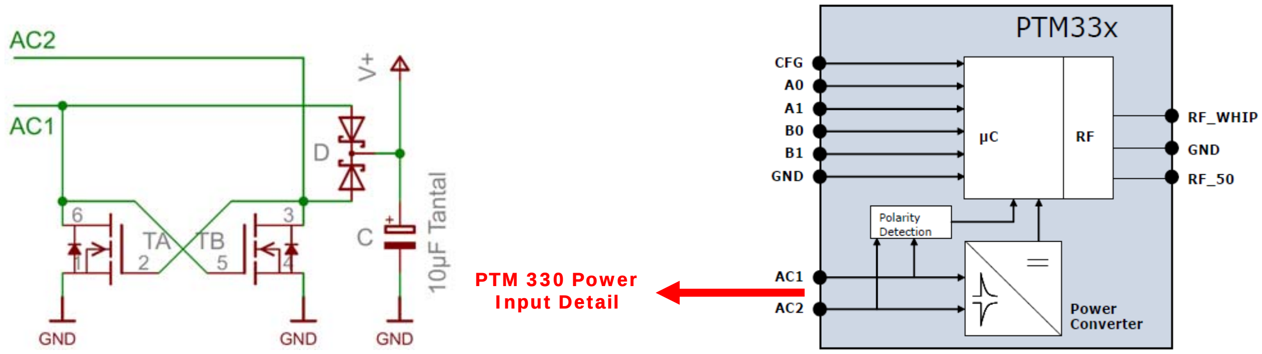
Required energy pulse amount (duration):

The duration of the applied energy pulse must be long enough to allow enough energy flowing from generator to device to start-up and transmit a complete radio telegram (containing 3 sub-telegrams) even in “worst case”. This duration strongly depends of the impedance match between the PTM 330 (as load) and the used energy generator, in particular case a battery. On the other hand, the pulse duration should not be unnecessarily long, since the in-excess drawn and stored energy would be always dropped (wasted) after transmitting of every complete telegram. If the device was longer connected to the battery, it would continuously draw senseless and important amount of current.

Important: due to its special for the ECO 200 optimized step-down converter design, when the externally applied supply voltage rising slope is too flat (e.g. impedance source too high) the device would never start-up, independent of how high the final voltage level will be!



As batteries have technologically predetermined nominal voltages and impedances, the only energy optimization factor remains the length of the energy pulse. As orientation, considering the device start-up time, as well as some energy transfer latency due to source to load impedance matching issues, a 20 ms wide, steep rising energy pulse would be a good starting point. An appropriate “mono-shot” circuit would e.g. fulfill this function. The required pulse duration can be then energy optimized according to worst case conditions / requirements using the DolphinView/Sniffer radio sub-telegram visualization tool and PTM 330 user manual requirements. The length of this energy pulse needs to be defined by measuring the remaining voltage on the initially completely discharged 10 µF tantalum input storage capacitor on PTM board after the (last) 3rd sub-telegram and depends on the specific battery parameters (voltage, impedance).



Note:

Depending on the application, parallel (at the same time!) to the applied energy pulse between the AC inputs, appropriate (e.g. push button pushed) digital input information must be also available in order to transmit an EnOcean "valid" switch telegram (e.g. rocker pushed).

This can be done by simply simultaneously connecting correspondingly digital A/B input to GND (i.e. analogue to PTM 250 behavior by pushing the rocker), sending already customer specific preconfigured telegrams (software configuration overrides hardwire input state of the inputs) or even electronically driven inputs e.g. by an external ultra low power µC (if e.g. battery powered). In this case, two leftover I/Os could e.g. also drive the AC inputs according required polarity.

In any case, a common GND path between the external µC and PTM 330 internal µC must be provided. Respect the corresponding limitations of the PTM 330 device (pull-up digital inputs leave open for "off" or connect to GND for "on", max. allowable voltages).

Energy Balance

Actually, PTM 330 is designed to be used together with the electro-mechanical energy harvester ECO 200. Both devices are optimized with regard to the best energy yield, meaning the ECO 200 output (impedance energy pulse shape, duration,) is optimally matched to the PTM 330 load. It has relative low output impedance around 25 Ω and delivers an about 4 ms long pulse peak up to 6 V when loaded by a PTM 330. The power input stage of the PTM 330 contains a rectifier, voltage polarity detector and an appropriate, high efficient step-down converter followed by an appropiate operational capacitor in order to deliver the required supply voltage and current for the electronics (required Dolphin chip start-up peak voltage > 2.6 V, thereafter PTM internally reduced to about 2.2 V for minimized energy consumption).

Required voltage level

According to the user manual, PTM 330 requires a short energy pulse > 5 V amplitude between the AC1 and AC2 (in typical use case delivered by electro-dynamical ECO200 generator).

Background: the power input stage of the PTM 330 integrates serial rectifier diodes D (see power input details picture above) followed by a step-down converter. The converter, optimized for the ECO 200 generator is designed to deliver at output the necessary start-up voltage pulse of > 2.6 V for the Dolphin chip, providing that the voltage at its input is at least as high (by 100% converter duty cycle). Knowing that between the input of the step-down converter and the AC paths there is an additional serial diode D voltage drop, the minimum required input voltage at the AC paths would be accordingly > 2.6 V + 0.6 V, or > 3.2 V. An aggravating factor is that this voltage pulse should be delivered at start-up, meaning under hardest load!

3 V coin batteries are therefore not suited for this application. The voltage hub between nominal open circuit voltage and minimal required start-up voltage level under load (and correspondingly usable energy amount) is not sufficient. Another limiting factor here is the limited Ampacity of the coin batteries, in conjunction with their relative high internal impedance (max. discharge current in range of few mA.) 3.6 V batteries with lower internal impedance would be better suited but inconvenient (much larger and more expensive, e.g. ½ AA type).

One alternative would be to apply the energy pulse between V+ and GND paths of the PTM 330 instead between AC1 and AC2. Through this "trick", the diode D forward voltage drop would be "jumped" and the required minimum starting voltage accordingly lowered even below 3 V. Since the PTM 330 can be customer specific SW configured (DolphinStudio and needle bed adaptor needed) for every single digital input combination, it could be set to transmit for A1 closed => Switch 1 ON, respectively A0 closed => Switch 1 OFF and similar for B1 respectively B0 (corresponding to Switch 2). In this case (AC1 and AC2 inputs not used), there will be actually no "release" Telegrams (corresponding to inversed polarity between AC1 and AC2) transmitted by contact opening (button released). The only disadvantage would be that then the PTM 330 can't be used anymore for dimming function (the Dimmer expects always a release telegram and interprets the time difference between push and release telegram to dimm up/down).

Another alternative therefore would be to use an additionally step-up converter like e.g. TLV61220 (SOT-23), with very low quiescent / switch-off current and adjustable output voltage) connected between a 3 V coin battery and the PTM 330 device driven by an external µC as described above, which would permit to generate the required output pulses.

Important:

During PTM device start-up, peak currents as high as some hundreds of mA (for one microsecond) respectively up to 25 mA (for one millisecond) during the radio telegram transmission will be drawn from the power supply. Since typical small (coin) batteries have very limited current pulse capability (relative high internal impedance), an external, e.g. SMD ceramic capacitor buffer > 10 µF parallel to the battery should be provided to avoid an accentuated voltage breakdown (during e.g. start-up) and long-term damaging of the battery. In order that the required energy pulse is immediately available, it is important that this buffer capacitor is directly paralleled to the battery. The leakage currents of such capacitors are in the range of nA and thus lower as the battery intrinsic self discharge rate.

Accordingly, the required current consumption for a complete telegram transmission roughly corresponds to a battery electrical draw (discharge) of about 100 µAs. Since nominal battery capacity is mostly provided in Ah respectively mAh, 100 µAs equals i.e. $100\ A \times 10^{-6} \times 1\ h/3600 = 0.000000028\ Ah$ battery electric discharge per transmitted telegram. From the nominal capacity point of view alone one CR2032 coin cell battery (typ. 0.2 Ah) could thus reach for Million of EnOcean radio telegrams.