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MINIATURIZED ELECTRONIC EVENT COUNTER

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Abstract

A miniaturized electronic event counter has been developed for applications, where high demands are put upon small dimensions, low weight and low triggering energy (i.e. for field tests of prostheses, orthoses, electrical stimulators, parameters etc). The counter is powered by three small hearing-aid batteries for a life of approximately one year. The maximum capacity is 8×10^6 counts. The counter is triggered either by a microswitch or by a digital as well as an analogue electrical signal. For the readout of the counter a special method is used, involving a readout unit which is connected to the counter via a micro miniature plug at readout occasions. The present version of the readout unit restricts the capacity to 5×10^5 counts.

Introduction

In the field of rehabilitation engineering evaluation of the benefits from various devices is essential. Unfortunately too many evaluations of this kind are totaly based on laboratory tests which means that the use of the device under normal conditions is neglected.

"Normal conditions" in this case means that the test subject should be observed in the environment where he needs and normally uses or would use the device.

When discussing evaluation in terms of acceptance one should be very careful under what circumstances a certain acceptance rate is achieved. It is our experience that an evaluation program which involves much extra attention to the patient gives higher acceptance rates than the normal fitting routines. This phenomenon is also confirmed by Dr Soerjanto, Utrecht (personal communication).

With this background it is obvious that the ideal functional evaluation would be a registration of a large number of parameters over a long time without any restrictions of the normal properties of the evaluation object and without any influence on the daily life of the test subject. This is unfortunately impossible to obtain by current technology. This work, however, is based on the idea that a reduction of the collection of data to counting the frequencies of a few different "events" still gives meaningfull information. With this strong reduction of data a technical solution should be possible which in all respects hardly alters the normal properties of the test object.

Such measurement tasks are commonly solved by applying conventional mechanical counters. In this case, however, this would be a too heavy and bulky solution even with the smallest available counters. Furthermore, it is desired that a counter for these needs should be able to count "events" of electrical as well as mechanical nature with a very low triggering energy, i.e. the energy demanded to step the counter one step.

The event counter system

To meet the requirements mentioned above a digital electronic circuit is used. An electronic circuit demands continuous current supply from a battery and therefore the lowest possible current drain is essential not to get bulky batteries. This implies in practice the choice of CMOS-technology circuit which in general has a quiescent current drain in the order of 1μA or less. Even with the smallest available mercury cells for hearing aids a life of 1 year is possible.

The readout of a counter is a function which requires a comparatively large amount of power and also, for the purposes in view, a direct readout put demands on volume and a suitable position in every application. These two points led us to a conception using an external readout unit powered from mains supply and connected to the counter itself, only when readout is needed.

To be able to perform the readout with an external readout unit both the CMOS-circuits available and the request for a connection with only a few poles implied a special readout procedure. This procedure can unfortunately not be presented until a patent is granted.

Properties of the system

The counter circuit has a maximum capacity of 8×10^6 counts. With the present readout unit the capacity is restricted to 5×10^5 counts. The counter is triggered by an input signal exceeding 2V (4Vbattery) with no demands on rise or fall times. This feature makes it easy to introduce a time condition by adding a simple RC-network. The input impedance is 1MΩ or more. The input signal can derive from any electric device or from any transducer. The most common transducer in this case perhaps is a microswitch.

The counter can also be used to measure the time duration for a certain event by forming an RC-oscillator of the input stage with for instance a frequency of 1 Hz and thenletting the event start the oscillator. Thus the time for a certain event is stored in seconds.

The counter is powered by three small mercury cells for hearing aids. Even with the smallest available batteries a life of 1 year is obtained. As a matter of fact the quiescent current drain of the circuit is so low that the life is almost exclusively restricted by the self-discharge of the battery dells.

A few external passive components are needed together with the counter. At present the components are soldered directly

on the IC-pins which gives a very compact design with the approximal dimensions 22x12x12 mm. See fig. 1. However, in a series production this would be a too expensive way to build the counter With conventional PC-board lay-out the expected dimensions will be 34x18x9.

A special battery carrier is developed with the dimensions 16xØ 13 mm. It is made from moulded PVC. The carrier is closed by a chromium plated disc, fitting into a slot in the PVC-body. The electric contact is obtained by this disc and a similar one at the bottom of the carrier. See fig. 2.

The readout unit has a 6-digit nixie display and it needs a four pole connection to the counter for the transmission of the information stored in the counter. See fig. 3. The readout procedure takes approximately 4 s. At readout the counter is reset to zero.

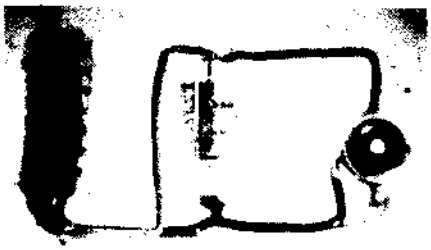

Fig. 1. From left: counter, battery carrier and microswitch in a demonstration hook up. Counter length 22 mm.

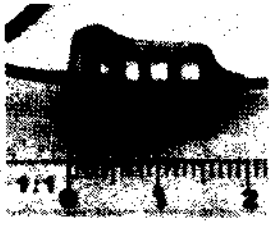

Fig. 2. Special battery carrier

Fig. 3. Prototype of display unit connected to a counter.

Practical experience and future possibilities

The first practical test of the system was to put the counter with microswitch into the heel of one of the authors shoes. This counter has worked satisfactory for 18 months giving results regularly with an average of 4000 steps per day. During the first year different types of battery carriers were tested.

Two evaluation projects applying the counters have started. One is a peroneal stimulator evaluation program where the counter is triggered by the stimulator itself, thus counting each step (with an average in one case of 3000 steps per day over one year). In the other project counters are mounted into all myoelectric hands applied counting how many times there has been an opening voltage applied to the motor for more than 0,3 s. The results from these projects will be presented in other contexts.

The measurement system can be used in many different contexts in many different ways and of course not only in rehabilitation engineering. Two examples can be mentioned:

The statistics of an analogue signal can be investigated by applying a number of time-measuring and/or event counting devices with different triggering levels.

The use of any function related to the use of another can be investigated by two event counters.

Ethical aspects

When using these counters for evaluation of different handicap-aids it is essential that the counters do not alter the properties of the aid. The perfect situation is when the user does not notice the presence of the counter(s) at all. However, it is the belief of the authors that the test subject should be informed and agree that the counter(s) are applied, to protect the personal integrity. However, it is unlikely that a subject would do extra activities due to the counters during such long periods of time that are discussed here.

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