A DIGITAL DISPLAY REVOLUTION COUNTER

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The precise reading of revolution frequency is subject to human error. The movement of the dial in a Parkinson Cowan dry spirometer or the fly wheel of a cycle ergometer are two examples from sports medicine where a digital display may be an advantage to the experimenter. This communication describes an inexpensive electronic unit which is adaptable to many requirements for revolution counting. The brief for the unit included versatility, a large digital display and an analog output so that a permanent oscillographic record may be obtained.

The pulse is obtained by using a reflective opto-switch consisting of an infra-red emitting LED* and photodarlington transistor sensor. The reflective opto-switch for the Parkinson Cowan dry spirometer is mounted below the rotating dial at the top of the gas meter (Fig. 1). Strips of aluminium foil act as the

Fig. 1: The reflective opto-switch (arrowed) mounted below the rotating dial of a Parkinson Cowan dry spirometer.
(Photo: G. Wilcock)

reflective surface and permit an accuracy of up to one tenth of a litre. The reflective opto-switch for the revolution rate of the Müller cycle ergometer was mounted on a spindle which rotated in synchrony with the movement of the pedals (Fig. 2). The reflective opto-switch and counter are linked together by a 2-core screened fly lead via a 4 pin-Din plug and socket. This means that a single counter may be used for any application, resulting in a considerable saving of cost.

Fig. 2: The reflective opto-switch (arrowed) mounted above the rotating spindle on a Muller cycle ergometer.
(Photo: G. Wilcock)

*LED is Light Emitting Diode.
IC BCD is Integrated Circuit Binary Coded Decimal

The pulse is fed to pin 14 of the 7490 IC decade counter. The display is driven by a 7447 IC BCD-to-* seven-segment decoder-driver. The count was extended

to 2 digits by taking the output from pin 11 on the 7490 IC to the input pin 14 on a similar IC. It was extended to 3 digits by the same procedure. The whole circuit is driven by a 5 volt stabilised power unit. A push switch is included (normally closed) so that the reset line (Pin 2 and 3 of the 7490 IC) is connected to negative. Momentarily opening the switch returns any count shown by the LED to zero. A toggle switch is also included between the incoming pulse and pin 14 and is labelled COUNT (on) and HOLD (off). In the COUNT position pulses are allowed to pass, but in the HOLD position no pulses get through and hence the display is constant. Pulses are also fed directly from the reflective opto-switch circuit to an output terminal from which an oscillographic recording may be produced. The position of the toggle switch does not affect this method of recording so digital values may be noted in the HOLD mode while the oscillograph records continuously.

Figure 3 shows the circuit diagram for the counter.

The authors' experience in using the revolution counter has shown that a single operator can record the

digital values reliably. This is of particular value in experiments which are by their nature labour intensive or require sustained periods of concentration. Reading errors on a rotating dial are not uncommon and for this reason two experimenters are often assigned to read the volume of expired air (V_E) with a dial recording spirometer. It is also common to have one experimenter recording the values for one minute while another continues with the successive minute. The digital read-out eliminated the need for a second observer as the minute values could be recorded without any further need to concentrate on the dial.

The output to an oscillograph has also proved to be of value because this allows the experimenter to interpolate values over any given time period. It is common practice to measure V_E every minute, but if the subject should stop breathing through the gas meter *within* a minute, then it is not possible to establish V_E during the minute immediately prior to stopping. The use of the oscillograph allows precise readings to be recorded at any time interval and is essential if the maximum V_E over the experimental period is required.

Legend for Figure 3

RESISTORS (0.25W)

R1	1 Kohms
R2	220 Ohms
R3	47 Kohms
VR4	100 Kohms (LIN.POT.)
R5	1 Kohms
R6-R12	82 Ohms

CAPACITORS

C1	10000 uF @ 25v
C3	0.22 uF
C3	0.47 uF
C4	0.02 uF

SEMI-CONDUCTORS

D1, D2	1N4001 DIODES
D3	BA 100 DIODE
TR1	BC 182 TRANSISTOR
IC1	7490
IC2	7447

SWITCHES

S1	MAINS ON/OFF
S2	COUNT/HOLD MODE
S3	RESET

Figure 3: Circuit diagram for digital counter.

A similar situation occurs when the reflective opto-switch is mounted on the Müller cycle. Experiments are presently being conducted by the authors to measure the maximum power generated during cycle ergometry. The timing of peak power cannot be predicted in advance so a precise measure of revolution frequency is essential which is made possible with this system. A change in the number of reflective strips will alter the sensitivity of the

system so the power generated by a single movement of the pedals may also be recorded. This principle can be extended to any rotational movement by adaptation of the ergometer and thus gives the opportunity for many forms of movement analysis. The digital display revolution counter is sufficiently flexible to support a large number of applications and it is hoped that the reader will find many opportunities to use the device.

LETTER TO THE EDITOR

*From Professor P. H. Fentem,
Professor of Physiology,
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20th May, 1981

Dear Sir,

Re: Sudden, unexpected death in sport

In the March 1981 issue of the journal you included papers presented at the Medicine in Sport Symposium in April 1980. The report of Dr. J. E. Davies' contribution entitled "Sports Injuries and Society" contains (p. 83) the following quotation, "A recent review of sudden deaths in sport by Fentem and Bassey (1979), came to the conclusion that there was no increase in sudden death during sport".

This statement is incorrectly attributed to Dr. Bassey and myself and is misleading. In the "Case for Exercise", a Sports Council Research Working Paper published in 1978, we were at pains to point out in the preface that the report "does not attempt to include discussion of the risks which may be involved in sport".

Nowhere do we pronounce on this important topic, nor is the evidence sufficient to allow us to do so. It is important to determine whether the sudden deaths which occur in those sports which carry no specific hazard are more than fortuitous. The readers may wish to refer to "Soldiers, sport and sudden death", *Lancet* (1980) i, 1235-1237 where Dr. Lynch reviews the causes of 56 sudden unexpected deaths occurring within 24 hours of sport or other strenuous exercise among British soldiers during the 10 years 1968-1977. The risk was estimated at 3.5 per annum per 100,000 man years among a population believed to undertake heavy exercise at least once per week and usually every day. Whether the risk is increased for those in middle age engaging in a vigorous sport intermittently remains to be assessed.