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A LIGHT LINK COUPLED CURRENT MONITOR

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Résumé. — Nous avons développé une unité de monitoring des faibles courants dans les sections neutres et dans le terminal du Tandem MP de Munich. Ce système consiste en un convertisseur courant fréquence et une diode émettrice de lumière, alimentés par piles. Les impulsions de lumière émises sont transmises par un guide de lumière et converties dans le récepteur en un signal adapté pour la lecture. La gamme de fonctionnement va de 100 pA à 70 μ A (1 nA à 700 μ A par option) correspondant à une fréquence d'impulsion comprise entre 0,1 Hz et 70 kHz.

Abstract. — For small current monitoring in the dead sections and in the terminal of the Munich MP-Tandem a unit has been developed consisting of a battery operated current to frequency converter and a light emitting diode. The emitted light pulses are transmitted by a light pipe and converted to a signal suited for the display in the receiver. The operating range is from 100 pA to 70 μ A (1 nA to 700 μ A optional) corresponding to a pulse frequency between 0.1 Hz and 70 kHz.

1. **Introduction.** — To operate a modern tandem accelerator with lenses and steering elements in the accelerating section, beam current monitoring in the terminal and in the dead sections is necessary. Also for diagnostic purposes monitors for beam currents, for charging currents and column currents in the terminal, and for ionization currents near the terminal are helpful.

Therefore a system for small current measurement and data transmission has been developed. It consists of a battery operated current to frequency converter which feeds a light emitting diode, an acrylic light guide [1] connecting the emitter diode to a photodiode on ground potential, a pulse amplifier, and a frequency to voltage converter.

2. **The sender.** — The sender has been designed with regard to high reliability, also under surge conditions, and to low current consumption from the battery. Its circuit diagram is shown in figure 1. The resistors R_1 and R_2 in connection with a spark gap at

the input, the surge arrestor and the transistor T_1 prevent the unit from being destroyed by sparks. The input current charges the capacitor C_1 , and so a voltage ramp is generated which is applied to the FET T_2 . At a certain height of the ramp (its value depends on the FET and the Z-diode), drain current begins to flow which flows also in the tunnel-diode TD. When the current exceeds its peak current the tunnel-diode goes into its high state, and the transistors T_3 and T_4 are switched on. The capacitor C_1 is then discharged to ground potential by the transistor T_5 , and after a short delay time, caused by the capacitor C_3 , a new cycle begins. As the slope of the ramp is proportional to the input current the pulse frequency is also proportional to the input current. At each cycle the transistors T_6 , T_7 , and T_8 are switched on and supply a current pulse to the LED.

TABLE I

Parts list

R_1 1.2 M Ω ; R_2 2×47 k Ω ; R_3 (*) approx. 330 Ω ; R_4 , R_5 , R_6 1 k Ω ; R_7 270 Ω ; R_8 220 Ω ; R_9 470 Ω ; R_{10} 0...10 Ω .

C_1 approx. 240 pF; C_2 100 nF; C_3 10 pF; C_4 100 nF; C_5 220 nF; C_6 10 μ F.

T_1 BC 183; T_2 BF 245; T_3 2N3012; T_4 2N2218; T_5 2N3011; T_6 2N3011; T_7 2N3012; T_8 2N5262.

TD 1N3713; LED HP 5082 - 4656.

Surge arrester type Siemens B 1 - C 90.

Batteries 2×9 V IEC 6F100.

(*) Adjusted at test.

FIG. 1

The sender is installed in a leak and pressure tight vessel because its components, particularly the battery, would not resist to evacuating and pressurizing the accelerator tank. The vessel is also a good shield for electromagnetic fields.

The connection to the point of measurement is done by a normal unshielded wire. The dielectric material of a shielded cable would be punched through by surges, and a short circuit would be caused by the track.

3. **The receiver.** — The light pulses, transmitted by a light pipe, are detected by a photodiode. A preamplifier, located near the diode is used to get pulses with a logic level. From these pulses an analog signal is derived, and its value is indicated in the control room.

4. **Operation.** — The system is suited for input currents between 100 pA and 70 nA (1 nA to 700 μ A, if C_1 is modified) corresponding to a transmission frequency from 0.1 Hz to 70 kHz. The supply current for the sender unit is not more than a few μ A at zero

input, and about 1 mA at 1 μ A input current. Hence, the battery life time is more than one year.

After a prototype had been successfully tested in the accelerator, seventeen units have been installed in the Munich MP-Tandem. They have been in continuous operation for about 8 000 hours under normal tandem conditions, including many sparks at terminal voltages up to 12 MV.

There was no failure up to now, even the batteries had not to be exchanged. Only the PVC mounting hardware of the prototype sender has been damaged by sparks, although the unit was *grounded* by a wire. One can conclude from the spark distance that the surges were in the order of several hundred kV. Therefore extremely good shielding of the electronic components is required, but it has been demonstrated that a closed steel box is a sufficient screening if an efficient surge filter is provided at the current feed through.

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References

- [1] JAKOB H., ROHRER L., SCHNITTER H., *Revue Phys. Appl.* **12** (1977).
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