Technical Note on the radiation patterns from OP232 infrared LEDs

The potential issue of OP232 infrared LEDs radiating with significantly off-axis beam patterns was raised by Stuart Aston of Birmingham University, during the last ALUK teleconference.

The test-rig shown in Figure 1 was therefore designed and constructed in order to try and answer this question.

The test-rig was constructed as follows: a V-groove and phosphor-bronze spring clamping arrangement held an OP232 LED in a fixed orientation at the top of a height-adjustable pillar. A BPX65 photodiode with a 1 mm square sensitive area was mounted in a similar V-groove above a moveable radius-arm, the photodiode being accurately at the same height above the baseplate as the OP232. The radius-arm could be swung through ±90°, relative to the 'straight-through' direction, using a drive-cord running around the perimeter of a semicircular plate. A single-turn potentiometer with a (measured) non-linearity of just ±0.2% over the desired 180° range was attached to the radius arm, and a single op-amp based interface to the potentiometer was arranged to give an output of ±9.000 volts at the ±90° end-stop positions of the arm. The face-to-face separation of the LED and photodiode was 120 mm.

The OP232 was powered by a Howland constant-current source, so that its case could be grounded, with a current of 34.8 mA. The photocurrent from the BPX65 was passed to a transconductance amplifier, having an 8.7 MΩ feedback resistor.

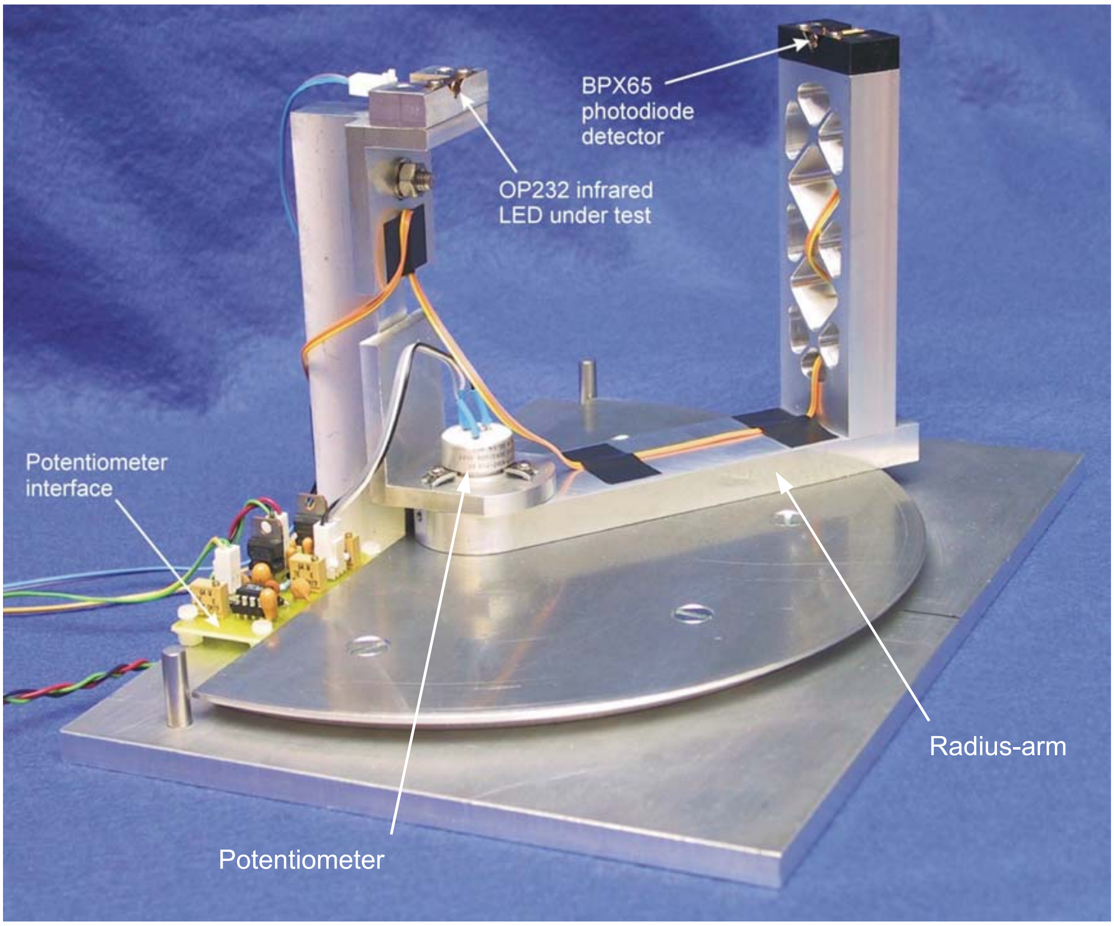

Fig.1. The angular-emission test-rig (base-plate size: 200 mm × 300 mm).

By sweeping the radius arm the emission pattern of the OP232 under test could then be recorded (although not directly as an XY plot), using a low-cost '12-bit' 2-channel *ADC-100* from *Pico Technology Ltd*.

Potentiometer Interface

A simple potentiometer was used for the measurement of the angular position of the radius arm, mainly on the grounds of time and cost—the same reasoning applying to the use of the *Pico Technology ADC-100*.

For future work, however, it may be advantageous to replace the potentiometer with an angular encoder having a resolution of at least 4000 ppr (pulses per revolution). In this way an angular resolution of ≤ 0.1° may be achieved over the full 180° range. Also, a single-channel dedicated 12- (or 16-) bit resolution ADC, used with (say) '256 ×' over-sampling, would allow the optical intensity to be measured with a 16-fold reduction in noise level. Both of these improvements could be incorporated into the same interface, in such a way as a save one data file per device under test to a PC—over a serial link, with no missing data. This would greatly streamline the measurement process, and would avoid 'missing data' glitches, which are occurring from time to time with the present data-logging system.

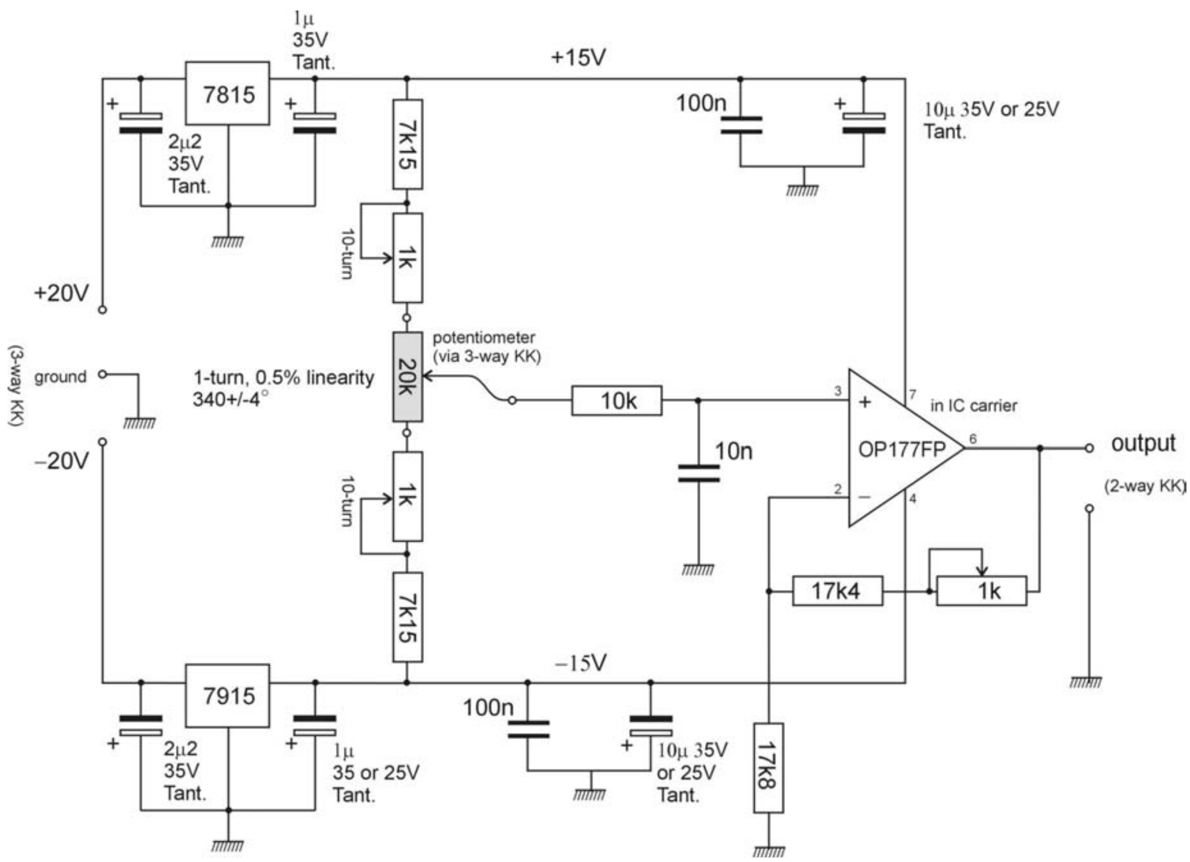

Fig.2. Potentiometer interface electronics, schematic.

Despite the simplicity of the interface, the linearity of the potentiometer-based measurement of the angular position of the radius arm was satisfactory, Figures 3 and 4 showing the full-span and deviations from linearity, respectively.

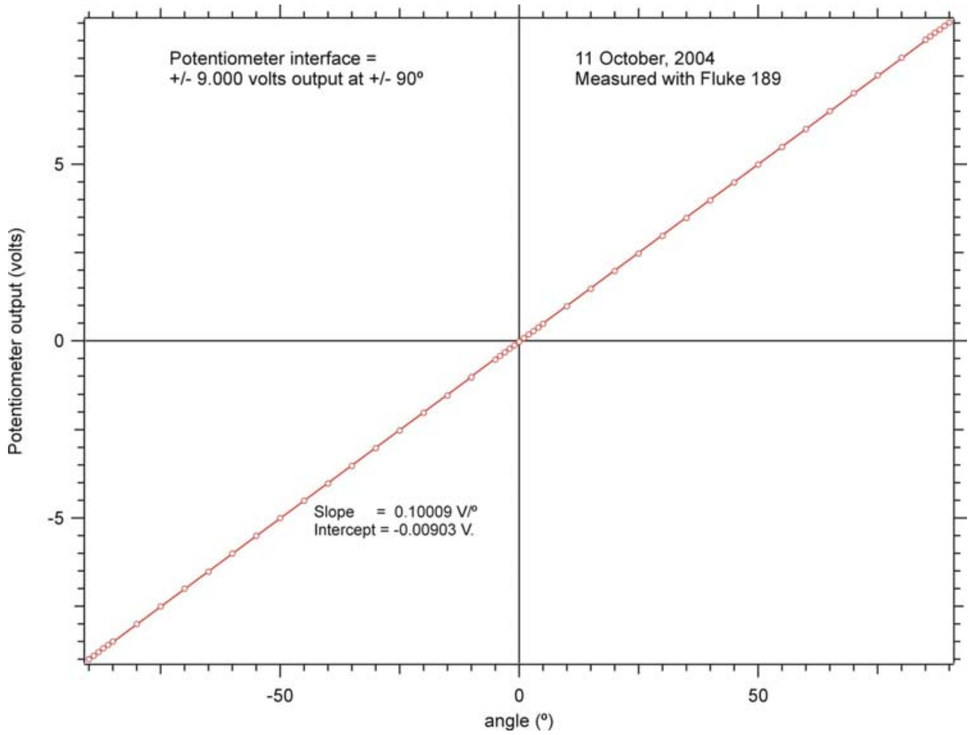

Fig.3. Linearity of the output vs radius-arm angle for the potentiometer interface.

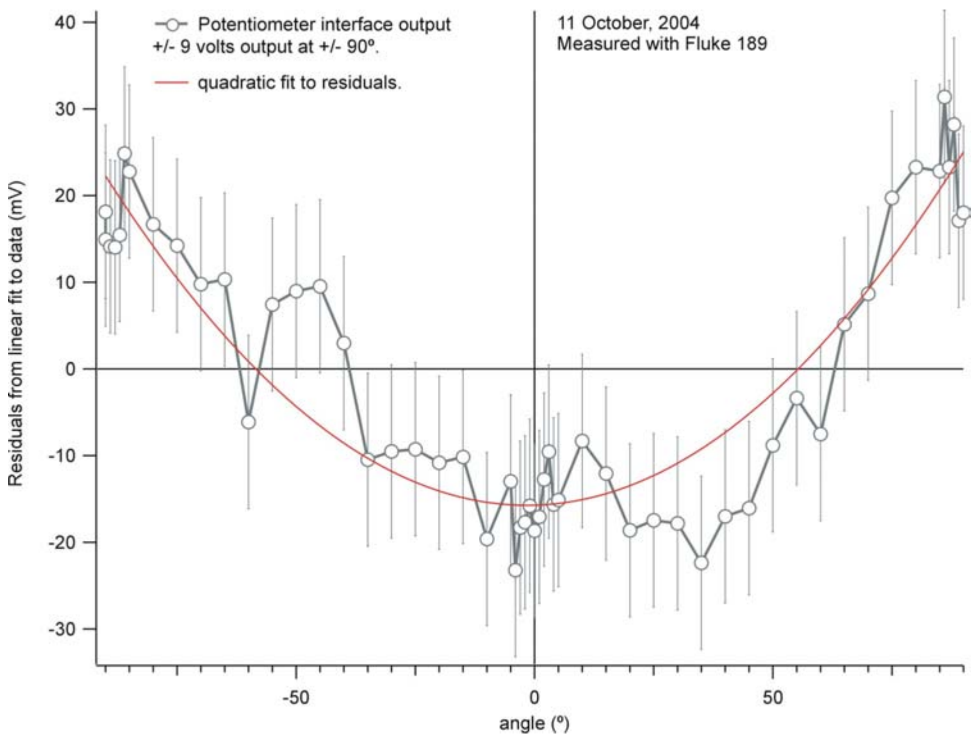

Fig.4. Residuals from a linear fit to the potentiometer output: the small deviation from linearity was essentially quadratic.

Results

As the apparatus was designed and constructed specifically for the purpose of measuring the angular distributions of the OP232 LED, it has clearly been completed in very short order, and so the measurements reported here are of course only preliminary results. Nevertheless all 25 of the first batch of OP232s have now been tested.

The results were very reproducible, as shown in Figure 5, although potentiometer noise in these single sweeps was visible. Further work on the detection (principally, electronics) side might be needed if further batches of LEDs destined for use in the Advanced LIGO OSEMs need to be checked, using this apparatus.

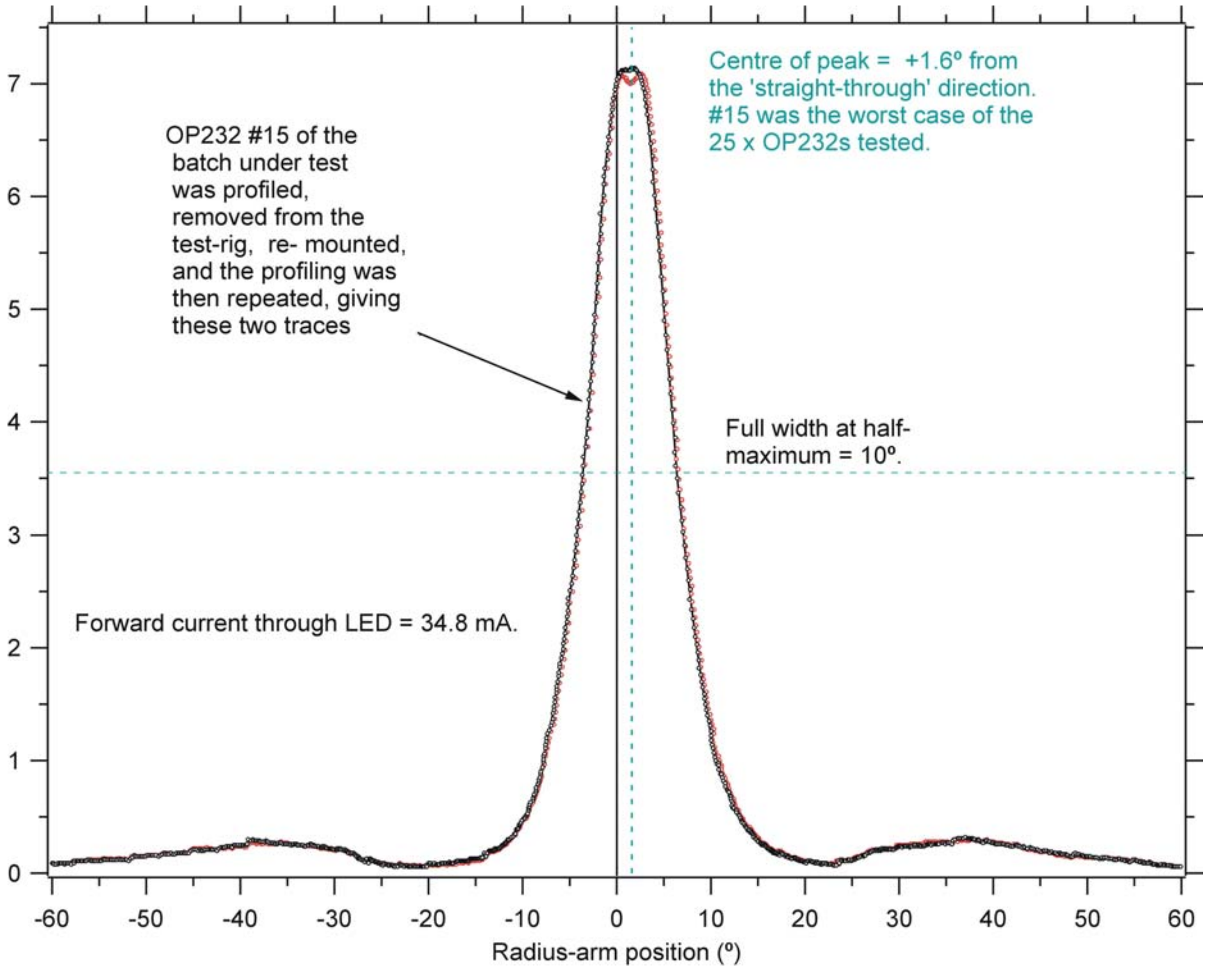

Fig.5. Emitted intensity vs angle for one of the OP232 LEDs (the worst case), also showing the typically very good re-positioning consistency for the devices in the test-rig (typically ±0.2°).

The standard deviation of the spread in peak emission angles for the batch of LEDs was just 1.01°, the worst-case LED having an emission peak just 1.6° off-axis.

Conclusion

Clearly, for the LEDs tested off-axis emission is not an issue.

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