SAM/SAM-III Sensor Signal Filter

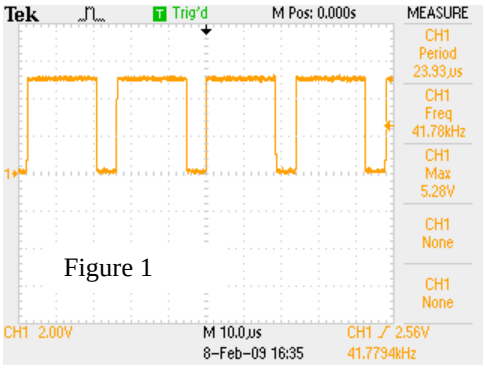


Figure 1

Introduction: The output signal from the SAM-III sensor is a pulse-width modulated waveform with a period range of 3 – 25 µs (frequency range about 40 – 300 kHz) and voltage range of 0 – 5 V (Fig. 1). The output is unbalanced and shares the sensor power ground.

Transmission of the waveform on cable over any appreciable distance will introduce waveform distortion. Also, the unbalanced signals from more than one sensor signal will generate crosstalk interference.

Field application: Three sensors were buried together in a fixture, and a 50 m long, 22 AWG, shielded twisted pair cable was used for power and signal transmission back to the SAM-III processor module. This run introduced considerable waveform distortion and ringing even though the length was short. The waveform jitter and crosstalk interference are not visible in the oscilloscope display image but were obviously present during testing (Fig. 2). The combination of distortion, crosstalk and jitter leads to inaccuracies in detection and counting of the waveform period by the SAM-III processor module.

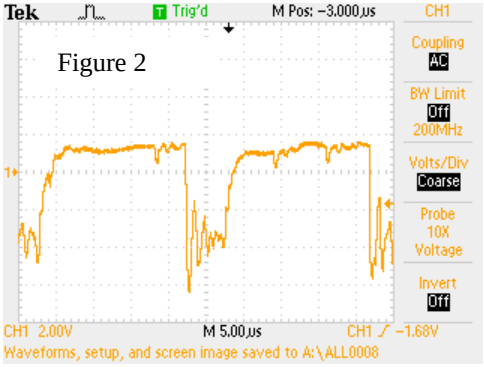
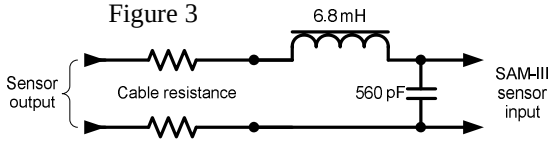


Figure 2

Filter: To reduce these effects, an LC low-pass filter was installed at the near-end of the cable between the sensor output and SAM-III processor module input (Fig. 3). The filter was designed by SAM-III user John Dubois. Neglecting line and inductor resistance, the cutoff frequency can be calculated from

$$f_c = \frac{1}{2 \cdot \pi \cdot \sqrt{L \cdot C}}$$

Figure 3



where f_c = cutoff frequency (Hz), L = inductance (H), and C = capacitance (F). For the values used (L = 6.8 mH, C = 560 pF), f_c = 81.6 kHz.

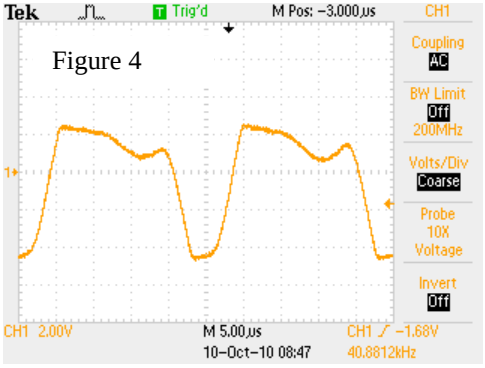


Figure 4

The filter eliminates the ringing on the waveform falling edge and reduces the effects of crosstalk interference (Fig. 4).

Crosstalk interference: In lieu of the filter, the crosstalk interference can be eliminated by using a separate shielded cable for each sensor. This will not reduce waveform distortion nor will it likely improve jitter performance (except jitter caused by crosstalk interference). Distortion and jitter can be reduced by using an adapter to convert the unbalanced sensor output for transmission on balanced twisted pair cable and then reconverting back to unbalanced for connection to the SAM-III processor module. If balanced transmission is used on shielded twisted pairs, a separate cable for each sensor will not be needed. An unbalanced-to-balanced adapter can be built from the SN65LBC184 (or similar) buffer/line driver integrated circuit original designed for EIA-485 applications.