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现代应用光学

激光测距系统整形模块和低通滤波模块优化设计

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摘要: 由于减小相位式激光测距系统的鉴相误差可提高测距精度, 本文对鉴相器前置整形模块和后置滤波模块进行了优化设计, 以提高鉴相精度。针对整形模块, 引入了迟滞比较器, 克服了传统开环比较电路在实际噪声条件下存在的多重触发缺陷, 解决了鉴相器输出方波高电平宽度不稳定的问题。针对滤波模块, 介绍了基于MC4044鉴相芯片的两种典型放大/滤波电路及其缺陷, 使用FilterPro软件设计了4阶有源低通滤波器, 并说明了它相对于典型设计的优势。实验结果表明: 相比于开环比较器, 本文设计的迟滞比较器避免了接地(GND)噪声引起的多重跳变现象, 输出方波的上升沿时间由1.66 μ s下降为108 ns; 与基于MC4044的两种典型放大/滤波模块设计相比, 本文设计的低通滤波电路克服了输出DC电平非线性变化的缺陷线性度(R2)值由0.908 3提高至0.999 9和灵敏度较低的缺陷(转化增益常量提高了96.5%), 而输出DC电平上的干扰信号峰峰值则由50~230 mV下降至10~20 mV, 有效减少了后级的A/D采样误差, 提高了鉴相精度。

关键词: 激光测距系统 鉴相精度 迟滞比较器 整形模块 放大/滤波模块

Optimization of Shaping Circuit and Low-pass Filter in Laser Ranging System

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Abstract: As the phase discrimination error of a phase laser ranging system effects its ranging accuracy, this paper optimizes the designs of a preceding stage (shaping circuit) and a subsequent stage (low-pass filter) in the phase detector. For the shaping circuit, a comparator with hysteresis was designed to avoid the multiple-triggered phenomenon caused by the noise on GND for open loop filters, and stabilizes the output of phase detector. For the low-pass filter, two typical amplifier/filter circuits based on MC4044 and their defects were introduced, a 4th-order low-pass filter was designed by using FilterPro, and its advantages were presented. Experimental results indicate that the multiple-triggered phenomenon is eliminated by using the hysteresis comparator designed, and the rise-time of output square wave falls to 108 ns from 1.66 μ s as compared with that of a traditional opened-loop comparator. Furthermore, the 4th-order filter designed in this paper improves the linearity and sensitivity of the DC output, the linearity(R2) increases from 0.908 3 to 0.999 9, and the convention gain improves by 96.5% as compared with that of the typical designs of amplifier/filter circuits. Moreover, the peak-to-peak value of the interference signal on a Low Pass Filter(LPF) DC output decreases from 50-230 mV to 10-20 mV, which reduces the phase detection error effectively.

Keywords: Laser ranging system Phase detection accuracy Comparator with hysteresis Shaping module Amplifier/filter module

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