

# 基于FPGA 乐曲演奏电路的设计

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[摘要] 采用 VHDL 语言设计了数控分频器电路，根据数控分频的原理，设计了乐曲演奏电路，用 MAX+plusII 编程工具进行逻辑综合和时序仿真，达到了预定的效果，与传统的纯硬件方法相比简单有效。  
[关键词] 现场可编程门阵列；VHDL；MAX+plusII；乐曲  
[中图分类号] TP271.82 [文献标识码] A [文章编号] 1673-1409 (2006) 02-0524-02

笔者用 VHDL 语言在现场可编程门阵列 (FPGA) 器件上实现了一种可编程的乐曲演奏电路。FPGA 的应用不仅缩短了开发周期<sup>[1]</sup>，而且稳定性很强，同时使深度模块的修改与开发变得很容易，因为它不需要改动硬件电路，只需要在软件上做些修改。

## 1 乐曲演奏电路原理

声音的频谱范围约在几十到几千赫兹，若能利用程序来控制电路产生一定频率的波形，接上扬声器就能发出相应频率的声音。而乐曲中的每一音符对应着一个确定的频率，而要准确地演奏出一首乐曲，仅仅让扬声器能够发声是不够的，还必须准确地控制乐曲的节奏，即每个音符的持续时间<sup>[2]</sup>。由此可见，乐曲中每个音符的发音频率及其持续的时间是乐曲能够连续演奏的 2 个关键因素。

该设计的关键是要准确地产生音乐中各音符所对应的频率信号，并根据乐曲要求按节拍输出。简易乐曲演奏器的原理框图如图 1 所示。

节拍控制电路产生节拍定时信号；音符产生电路按节拍要求产生乐曲所需要的音符；预置数产生电路受音符产生电路控制，产生与该音符频率相应的预置数，送计数器的置入数据输入端，可变频率信号发生器根据不同的预置数产生相应的频率信号<sup>[3]</sup>，从而完成乐曲的演奏功能。

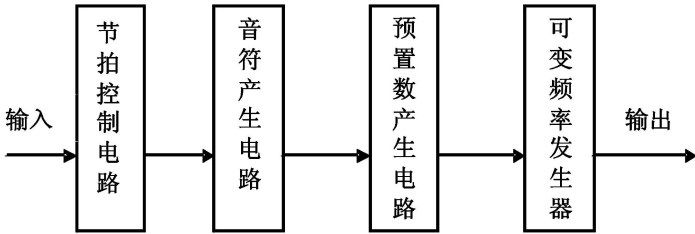


图 1 乐曲演奏器的原理框图

## 2 模块设计

### 2.1 节拍控制电路

节拍控制电路以乐曲中最短音符的节拍为基准，产生乐曲所需的全部节拍。考虑到一遍演奏完需要间隔时间，所以选定节拍控制计数器的计数状态为 28+2 个，其中间隔时间为 2 个有效状态。

### 2.2 可变频率信号发生器

可变频率信号发生器由可变模值计数器实现。由于系统要求产生的信号频率较高，因此选用 3M Hz 的脉冲信号可作为可变模值计数器的计数脉冲。这样，需要产生的音符与频率及分频系数就有一一对应的关系。

[收稿日期] 2006-04-25

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### 3 用 VHDL 实现系统设计

#### 3.1 顶层模块设计

图 2 中的 YOUYI 模块是分频电路，给出相应乐曲的乐谱，通过给定的基准的时钟信号频率，在该电路就会得到相应的频率，从而达到分频的目的<sup>[4]</sup>；FANA 模块是节拍电路，因为每个乐曲都有自己的演奏节奏，通过该模块就可以得到相应的频率节奏，从而可以控制演奏节奏。

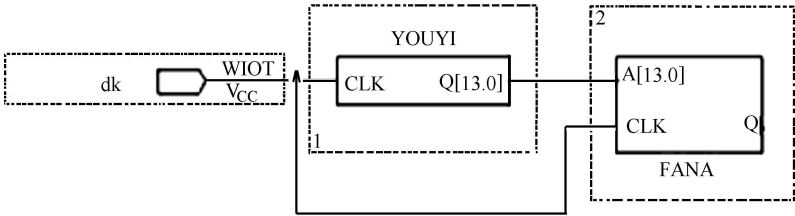


图 2 顶层文件电路图

#### 3.2 底层语言描述

底层元件的 VHDL 源程序部分描述<sup>[2]</sup>：

```
library ieee ;
use ieee.std_logic_1164.all ;
use ieee.std_logic_unsigned.all ;
entity youyi is
port
(
    clk : in std_logic ;
    q : out integer range 0 to 10204
);
end youyi ;
when 0=>q<=7653;
if cnt 2<1 then
    cnt 2:=cnt 2+1;
else
    cnt 2:=0;
    n:=1;
end if ;
end process ;
end behav
```

#### [参考文献]

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[编辑] 易国华

foundation is laid down for hydrocarbon exploration .

**Key words** : Pengtan -Yangjing Area ; reservoir physical property ; pore ; permeability

510 **Synthesis and Performance Analysis on Polymer Scale Inhibitor for Barium Ion Stabilization**

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**Abstract** : A water solvent and persulfate are used as initiators , and MA /AA /VAC are used as monomers for synthesizing .The influence of polymerization conditions on BaSO<sub>4</sub> scale is studied , and proper polymerization process is determined .The experimental results show that this copolymer scale inhibitor have excellent inhibitor capability for barium sulfate scale .The copolymer has good effect for preventing barium sulfate with the highest scale preventing rate of 92.1% .

**Key words** : scale inhibitor ; scale preventing performance ; barium sulfate

524 **Design of Circuit Based on FPGA Music Performance**

*PENG Li , ZHU Xian-you (Yangtze University , Jingzhou 434023)*

**Abstract** : VHDL is used to design a frequency divider which is controlled by digital quantity .According to the theorem of frequency divider controlled by digital quantity , a circuit of music performance is designed .MAX +plusII programming tool is used to conduct a logic synthesis and simulation , by which the most desirable effect is achieved .It is simple compared to the traditional method of using hardware only .

**Key words** : FPGA ; VHDL ; MAX +plusII ; music

526 **Application of Multisim in the Electronic Circuit Design**

*XU Yan (Suqian College , Suqian 223800)*

**Abstract** : Multisim , a kind of emulating software , is one of the commonly used EDA .The thesis summarizes the functions , characteristics and usage of Multisim 8.0 , especially its “real time emulation” .Multisim 8.0 accelerates the development of the hardware electric circuit , and its all-around emulating functions also guarantee the accuracy of electric circuit .

**Key words** : Multisim ; design of circuit ; EDA ; software application ; circuit emulation

531 **Design of A Hot Water Supply System Based on Heating Pump and Constant Temperature and Pressure**

*NE Shaojing (Yangtze University , Jingzhou 434023)*

**Abstract** : Scheme of overall design is discussed .The diagram of working principle of the hot water system based on heating pump and constant temperature and pressure is introduced .Designed temperature and pressure control systems are described .Water temperature is controlled to 50 ~ 60℃ , water pressure is below 0.5MPa for safety water supply .Both temperature and pressure are controlled by a single chip computer .

**Key words** : heating pump ; MSC1210 ; low power consumption ; monitoring and control system

535 **Study on PT Model for ATP emtp Emulator**

*LI Jing-yi , QUAN Yu-sheng , LI Xue-peng , MA Yan-wei (North China Electric Power University , Beijing 102206)*

**Abstract** : PT is the important component of producing ferroresonance , the parameter of PT has the