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**летательных аппаратов “**

**КУРСОВАЯ РАБОТА**

**по курсу “*Электронная схемотехника* “**

**тема проектирования** “***Разработка принципиальной схемы генератора***

***чисел в двоичном коде на D-триггерах****”*

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1. ***Составление таблицы истинности ( таблицы переходов триггеров ) .***

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| ***Десятич­ное число*** | **Q3** | **Q2** | **Q1** | **Q0** | **D3** | **D2** | **D1** | **D0** |
| **0** | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 |
| **7** | 0 | 1 | 1 | 1 | 1 | 1 | 1 | 0 |
| **14** | 1 | 1 | 1 | 0 | 1 | 1 | 1 | 1 |
| **15** | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 |
| **8** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| **1** | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 |
| **2** | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 1 |
| **9** | 1 | 0 | 0 | 1 | 1 | 0 | 1 | 0 |
| **10** | 1 | 0 | 1 | 0 | 0 | 0 | 1 | 1 |
| **3** | 0 | 0 | 1 | 1 | 1 | 0 | 1 | 1 |
| **11** | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 0 |
| **4** | 0 | 1 | 0 | 0 | 1 | 1 | 0 | 0 |
| **12** | 1 | 1 | 0 | 0 | 0 | 1 | 1 | 0 |
| **6** | 0 | 1 | 1 | 0 | 0 | 1 | 0 | 1 |
| **5** | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 |
| **0** | 0 | 0 | 0 | 0 |  |  |  |  |

**Q0 .. Q3** - входные переменные

**D0 .. D3** - логические функции

1. ***Составление карт Карно (минимальных логических функций).***

**D3**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q3Q2** | **Q1Q0** | | **00** | | **01** | | **11** | | **10** | |
| **00** | | 0 | | 0 | | А 1 | | 1 | |
| **01** | | 1 Д | | 0 | | 1 Б | | 0 | |
| **11** | | 0 | | 1 Г | | В 1 | | 1 | |
| **10** | | 0 | | 1 | | 0 | | 0 | |

**\_ \_ \_ \_ \_ \_ \_**

D3=Q1Q3Q2 + Q1Q0Q3 + Q1Q3Q2 + Q1Q0Q3 + Q1Q0Q3Q2 =

**\_ \_ \_ \_ \_ \_ \_**

= Q1Q3Q2  ⋅ Q1Q0Q3  ⋅ Q1Q3Q2 ⋅ Q1Q0Q3 ⋅Q1Q0Q3Q2

**D2**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q3Q2** | **Q1Q0** | | **00** | | **01** | | **11** | | **10** | |
| **00** | | 1 B | | 0 | | 0 | | 0 | |
| **01** | | 1 | | 0 | | Б 1 | | 1 | |
| **11** | | 1 А | |  | | 0 | | 1 | |
| **10** | | 0 | | 0 | | 1 Г | | 0 | |

**\_ \_ \_ \_ \_ \_**

D2= Q0Q2 +Q1Q3Q2 + Q1Q0Q3 + Q1Q0Q3Q2 =

**\_ \_ \_ \_ \_ \_**

= Q0Q2 ⋅Q1Q3Q2 ⋅ Q1Q0Q3 ⋅ Q1Q0Q3Q2

**D1**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q3Q2** | **Q1Q0** | | **00** | | **01** | | **11** | | **10** | |
| **00** | | 1 | | 1 A | | 1 Б | | 0 | |
| **01** | | 0 | | 0 | | 1 | | 0 | |
| **11** | | 1 В | | 0 | | 0 | | 1 Г | |
| **10** | | 0 | | 1 Д | | 0 | | 1 | |

**\_ \_ \_ \_ \_ \_ \_ \_**

D1= Q1Q3Q2 + Q1Q0Q3 + Q0Q3Q2 + Q1Q0Q3 + Q1Q0Q2 =

**\_ \_ \_ \_ \_ \_ \_ \_**

= Q1Q3Q2 ⋅Q1Q0Q3 ⋅Q0Q3Q2 ⋅Q1Q0Q3 ⋅Q1Q0Q2

**D0**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q3Q2** | **Q1Q0** | | **00** | | **01** | | **11** | | **10** | |
| **00** | | 1 Б | | 0 | | 1 | | 1 B | |
| **01** | | 0 | | 0 | | 0 | | 1 | |
| **11** | | 0 | | 0 | | 0 | | 1 A | |
| **10** | | 1 | | 0 | | 0 | | 1 | |

**\_ \_ \_ \_ \_ \_ \_ \_ \_ \_**

D0= Q1Q0 +Q0Q2 + Q1Q3Q2 = Q1Q0 ⋅ Q0Q2 ⋅ Q1Q3Q2

1. ***Составление таблицы истинности (проверка) .***

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| дес |  |  |  |  |  |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| чис  ло | Q3 | Q2 | Q1 | Q0 |  |  | |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |
| **7** | 0 | 1 | 1 | 1 | 0 | 1 | 0 | | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 |
| **14** | 1 | 1 | 1 | 0 | 0 | 0 | 1 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 1 | 1 | 1 | 1 |
| **15** | 1 | 1 | 1 | 1 | 0 | 0 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| **8** | 1 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 1 |
| **1** | 0 | 0 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| **2** | 0 | 0 | 1 | 0 | 1 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 |
| **9** | 1 | 0 | 0 | 1 | 0 | 0 | 0 | | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 0 |
| **10** | 1 | 0 | 1 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | 0 | 0 | 0 | 1 | 1 |
| **3** | 0 | 0 | 1 | 1 | 1 | 1 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 1 | 1 |
| **11** | 1 | 0 | 1 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| **4** | 0 | 1 | 0 | 0 | 0 | 0 | 0 | | 0 | 1 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| **12** | 1 | 1 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 | 0 |
| **6** | 0 | 1 | 1 | 0 | 0 | 0 | 0 | | 0 | 0 | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 | 1 |
| **5** | 0 | 1 | 0 | 1 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| **0** | 0 | 0 | 0 | 0 | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 1 | 1 |

1. ***Построение временных диаграмм .***

***с***

*0 7 14 15 8 1 2 9 10 3 11 4 12 6 5 0*

***Q3***

***Q 2***

***Q 1***

***Q 0***

1. ***Разработка альтернативной схемы .***

Карты Карно для D3 и D1 остаются прежними (см. стр. 4 - 5) .

**D2**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q3Q2** | **Q1Q0** | | **00** | | **01** | | **11** | | **10** | |
| **00** | | 1 B | | 0 | | 0 | | 0 | |
| **01** | | 1 | | 0 | | Б 1 | | 1 | |
| **11** | | Г 1 | | 1 | | 0 | | 1 А | |
| **10** | | 0 | | 0 | | 1 Д | | 0 | |

**\_ \_ \_ \_ \_ \_ \_**

D2= Q1Q0Q2 +Q1Q3Q2 + Q1Q0Q3 + Q1Q3Q2 + Q1Q0Q3Q2 =

**\_ \_ \_ \_ \_ \_ \_**

= Q1Q0Q2 ⋅Q1Q3Q2 ⋅Q1Q0Q3⋅Q1Q3Q2 ⋅Q1Q0Q3Q2

**D0**

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Q3Q2** | **Q1Q0** | | **00** | | **01** | | **11** | | **10** | |
| **00** | | 1 Б | | 0 | | 1 | | 1 B | |
| **01** | | 0 | | 0 | | 0 | | 1 | |
| **11** | | 0 | | 0 | | 0 | | 1 A | |
| **10** | | 1 | | 0 | | 0 | | 1 | |

**\_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_**

D0= Q1Q0 +Q1Q0Q2 + Q1Q3Q2 = Q1Q0 ⋅ Q1Q0Q2 ⋅ Q1Q3Q2

***7. Результат сравнения двух схем.***

|  |  |  |  |
| --- | --- | --- | --- |
| Параметры | №схемы | принципиальная  схема (№1) | альтернативная принципиальная  схема (№2) |
| *количество микросхем* | | 12 | 12 |
| *количество незадействованных элементов* | | 2 (3-х вх.элем.’’И-НЕ’’)  1(4-х вх.элем. ’’И-НЕ’’)  3 (3-х вх.элем.’’И-НЕ’’) | 2 (3-х вх.элем.’’И-НЕ’’)  1 (2-х вх.элем.’’И-НЕ’’) |

*Вывод: в результате сравнения двух разработанных принципиальных схем генератора чисел в двоичном коде можно сказать, что по количеству задействованных микросхем схема*

*№1 более предпочтительна.*

***ЛИТЕРАТУРА***

***1.***

***2.***

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