# PROGRAMMABLE FUNCTION GENERATOR .

**Lab Duration:** Three weeks

## Pre-Lab

Design a function generator that will meet the specifications shown below. Submit a full circuit diagram showing all standard component values and also include all of your design work.

**CAUTION 1**: The AD7541 has been converted to an 11-bit DAC by grounding the LSB.

Therefore use $V_{o1} = -V_{REF} \times \frac{BIN_1}{2^{11}}$ where $BIN_1$ = 0 to $1000_{dec}$ Do not use N = 12

NOTE: The MSB of the AD7541 has been grounded as we will not need it.

**CAUTION 2**: The DAC0800 is an 8 bit DAC but we only use $BIN_2$ = 0 to $100_{dec}$

Use $I_O = I_{REF} \times \frac{BIN_2}{2^8}$

| N | Vsup (V) | Vtri ($V_{PP}$) | Vsq ($V_{PP}$) | BIN-1 min | Fmin (Hz) | BIN-1 max | Fmax (Hz) | BIN-2 min | D/C min | BIN-2 max | D/C max |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | ±15 | 20 | 27 | 0 | 0 | $1000_{dec}$ | 1000 | 0 | 0% | $100_{dec}$ | 100% |
| 2 | ±15 | 19 | 27 | 0 | 0 | $1000_{dec}$ | 1200 | 0 | 0% | $100_{dec}$ | 100% |
| 3 | ±15 | 18 | 27 | 0 | 0 | $1000_{dec}$ | 1400 | 0 | 0% | $100_{dec}$ | 100% |
| 4 | ±15 | 17 | 27 | 0 | 0 | $1000_{dec}$ | 1600 | 0 | 0% | $100_{dec}$ | 100% |
| 5 | ±15 | 16 | 27 | 0 | 0 | $1000_{dec}$ | 1800 | 0 | 0% | $100_{dec}$ | 100% |
| 6 | ±15 | 15 | 27 | 0 | 0 | $1000_{dec}$ | 2000 | 0 | 0% | $100_{dec}$ | 100% |
| 7 | ±12 | 14 | 21 | 0 | 0 | $1000_{dec}$ | 2200 | 0 | 0% | $100_{dec}$ | 100% |
| 8 | ±12 | 13 | 21 | 0 | 0 | $1000_{dec}$ | 2400 | 0 | 0% | $100_{dec}$ | 100% |
| 9 | ±12 | 12 | 21 | 0 | 0 | $1000_{dec}$ | 2600 | 0 | 0% | $100_{dec}$ | 100% |
| 10 | ±12 | 11 | 21 | 0 | 0 | $1000_{dec}$ | 2800 | 0 | 0% | $100_{dec}$ | 100% |
| 11 | ±12 | 10 | 21 | 0 | 0 | $1000_{dec}$ | 3000 | 0 | 0% | $100_{dec}$ | 100% |
| 12 | ±12 | 9 | 21 | 0 | 0 | $1000_{dec}$ | 3200 | 0 | 0% | $100_{dec}$ | 100% |

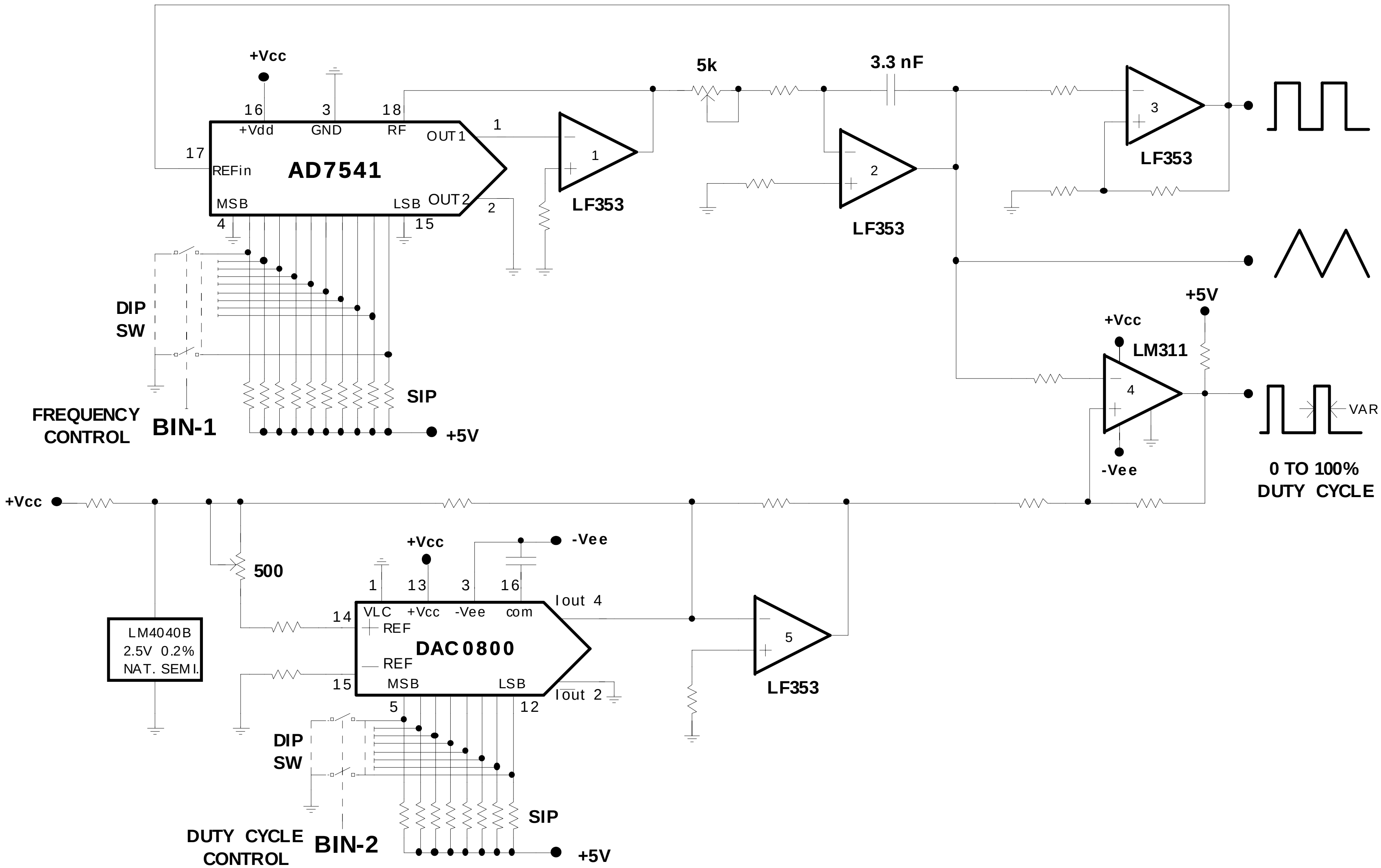
Available 5% standard resistors

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | 1.2 | 1.5 | 1.8 | 2.2 | 2.7 | x $10^N$ |
| 3.3 | 3.9 | 4.7 | 5.6 | 6.8 | 8.2 | N= … -3,-2,-1,0,1,2,3 … |

**Capacitors:** 3.3 nF and 0.33 µF **Pots:** one 500 pot and one 5k pot **Op amps:** LF353

**NOTE:** Use 0.33 µF to by-pass supply pins of IC's to ground.

CIRCUIT DIAGRAM



**LAB PROCEDURE**

1. Assemble circuit and apply correct supply voltages. Now de-bug circuit !!!!!

2. Observe regular square wave O/P and triangular O/P. Record waveforms and label peak voltages.

3. Using the frequency meter - COUNT IN input of frequency generator - calibrate $F_{max}$ that corresponds to $BIN_1 = 1000_{dec}$ to the exact value you were assigned using the 5k pot.

4. Using the frequency meter and the digital voltmeter, measure the following - $V_{O1}$ is a squarewave therefore the rms voltage read by the DMM will also be the peak voltage of $V_{O1}$.

| BIN-1 | Expected | Measured | Expected | Measured |
|---|---|---|---|---|
| | (Hz) | (Hz) | $V_{01}$(p) | $V_{01}$(p) |
| 0 | | | | |
| 1 | | | | |
| 2 | | | | |
| 4 | | | | |
| 8 | | | | |
| 16 | | | | |
| 32 | | | | |
| 64 | | | | |
| 128 | | | | |
| 256 | | | | |
| 512 | | | | |
| 1000 | | | | |

5. Measure the rise and fall times of $V_{O3}$ as well as the slew rate - compare to typical value from data sheets.

6. Test $BIN_2$ = 1, 2 and 4 to see if you get close to 1%, 2% and 4% duty cycle. If you are not close to the desired duty cycle, you need to trim the resistor right above the DAC0800. Do not go to step 6 before this is done.

7. Calibrate 100% duty cycle with 500Ω pot when $BIN_2 = 100_{dec}$ and then measure the following:

| BIN-2 | Expected | Measured | Expected | Measured |
|---|---|---|---|---|
| | $V_{o5}$ DC (V) | $V_{o5}$ DC (V) | % D/C of $V_{O4}$ | % D/C of $V_{O4}$ |
| 0 | | | | |
| 1 | | | | |
| 2 | | | | |
| 4 | | | | |
| 8 | | | | |
| 16 | | | | |
| 32 | | | | |
| 64 | | | | |
| 100 | | | | |

**CIRCUIT DEMO**

Teacher Signature:____________________________