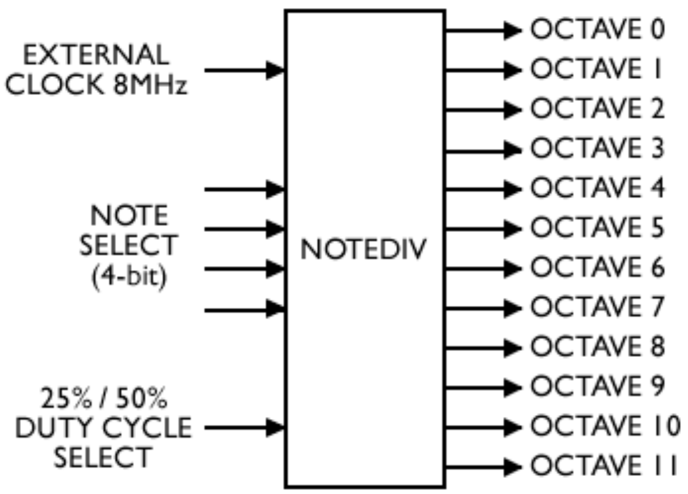
Electric Druid Note Divider NOTEDIV 1

Introduction

The Electric Druid Note Divider chip is a modern replacement for "top octave generator" or "top octave synthesizer" (TOG or TOS) chips . Top octave generators were commonly used in electric organs and string machines in the 1970's, and turn up in several other odd places too.

The original chips are now difficult to obtain and expensive, but their operation is simple. They use several counters to take a high frequency clock signal and produced equal tempered note frequencies. Typical clock frequencies were 1MHz or 2MHz, and the "top octave" produced usually ran from C = 8368Hz or even C = 4184Hz down. This top octave was then run to a series of flip-flop dividers (one for each note) to produce all the lower octaves.



This new chip improves on the original TOG/TOS chips by providing a wider range of octaves, starting an octave or two higher than typical, at C = 16744Hz. The chips provide 12 octaves down from here, which takes the range into subaudio. It also offers a pin which can select the duty cycle, either a 50% pure square wave, or a 25% pulse wave. This selection affects all of the chip's outputs. Since the two duty cycles have very different harmonic structures, this offers an interesting voicing possibility for organs or string synths based on the chip.

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Features

High output frequency

Unlike original TOG chips which only produced notes from C = 8368Hz down, this chip can produce notes another octave higher to C = 16736Hz.

Wide range of octaves

The NOTEDIV chip produces 12 octaves, reaching all the way down to 4Hz.

Can be used with master clock modulation

The 8MHz External Clock can be generated from a VCO, for example a 74HC4046. A example of this is shown in the Application Notes section.

50% Square / 25% Pulse Duty Cycle Selection

The chip includes a DUTY CYCLE input which selects between a 50% square wave output, or a 25% pulse wave output.

The square wave produces a hollow tone with only odd harmonics. The strongest harmonic is the third.

The pulse wave has significant amounts of even harmonics, with the second harmonic being the strongest This gives it a much rounder sound with a pronounced "octave" character.

Note Select Input

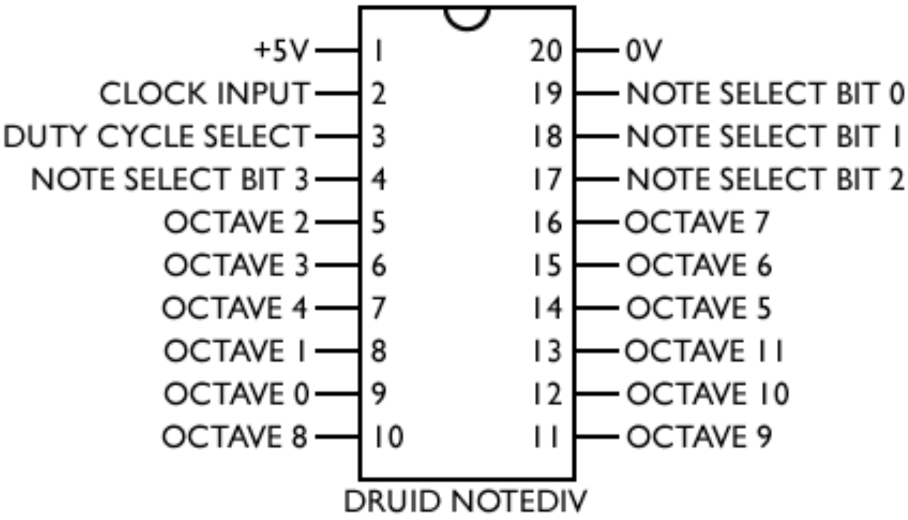
The chip has a 4-bit binary input which is read at start-up and used to configure the chip. Depending on the code on these four pins, the chip will produce one of thirteen notes, complete with 11 other octaves.

Classic 1970's Divider Ratios

Part of the sound of 1970's combo organs and string synths comes from the slight tuning errors introduced by the division ratios used in the TOG chips. These chips used an integer division to approximate the twelfth-root-of-two ratio of equal temperament notes. The NOTEDIV chip uses the same ratios for the same sound. From Low C to High C, they are:

÷478, ÷451, ÷426, ÷402, ÷379, ÷358, ÷338, ÷319, ÷301, ÷284, ÷268, ÷253, ÷239

Pinout Diagram



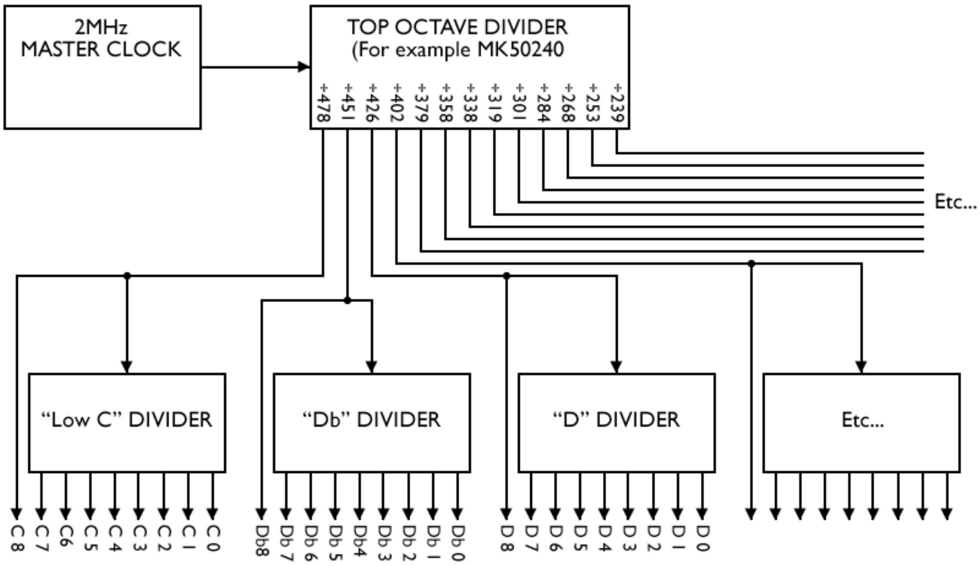
Pin	Function	Details	Notes
1	+5V	Power supply	
2	CLOCK INPUT	0-5V digital input	An 8MHz external clock is required
3	DUTY CYCLE SELECT	0-5V digital input	+5V = 50% Square wave 0V = 25% Pulse wave Note this pin has an internal pull-up, so if not connected square waves are selected.
4	NOTE SELECT BIT 3	0-5V digital input	See Pin 17-19
5	OCTAVE 2	0-5V digital output	
6	OCTAVE 3	0-5V digital output	
7	OCTAVE 4	0-5V digital output	
8	OCTAVE 1	0-5V digital output	
9	OCTAVE 0	0-5V digital output	The lowest octave, sub-audio, 8 to 4Hz
10	OCTAVE 8	0-5V digital output	
11	OCTAVE 9	0-5V digital output	
12	OCTAVE 10	0-5V digital output	
13	OCTAVE 11	0-5V digital output	The highest octave, 8368 to 16736 Hz, depending on note selected.

Pin	Function	Details	Notes
14	OCTAVE 5	0-5V digital output	
15	OCTAVE 6	0-5V digital output	Produces A=440Hz when NOTE SELECT is set to 9 (e.g. with pins 17 & 18 grounded)
16	OCTAVE 7	0-5V digital output	
17	NOTE SELECT BIT 2	0-5V digital input	In conjunction with Pin 4, these inputs select which note the chip will produce. Valid inputs run from 0 to 12; C, Db, D, Eb, E, etc up to the high C.
18	NOTE SELECT BIT 1	0-5V digital input	
19	NOTE SELECT BIT 0	0-5V digital input	
20	0V	Power supply	

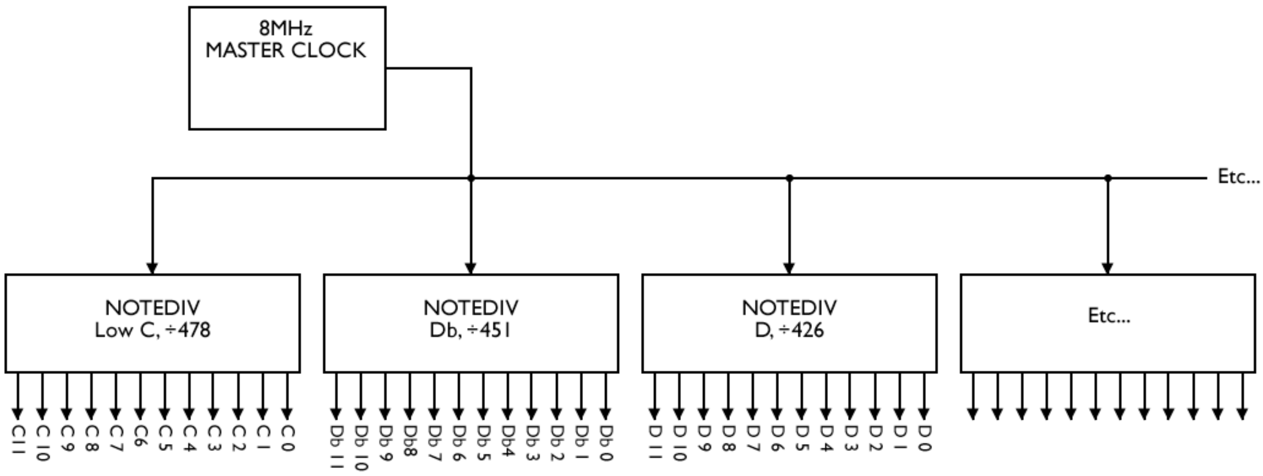
Application Notes

General Layout

The original Top Octave Generator systems used a master clock, followed by the TOG chip itself, with octave dividers fed from each note output.



The NOTE DIV chip divides this work up slightly differently, putting one note output and its associated divider on a single chip. This removes the need for a separate TOG chip.



Note the higher clock frequency too - this provides the higher output frequencies which the original chips couldn't manage.

A complete tone generator board for a electronic organ or string synth can be done with one high-frequency oscillator and twelve NOTEDIV chips.

Basic circuit diagram

Note Select input

The NOTE SELECT inputs allow the chip to be configured to produce 12 octaves of any equal temperament note.

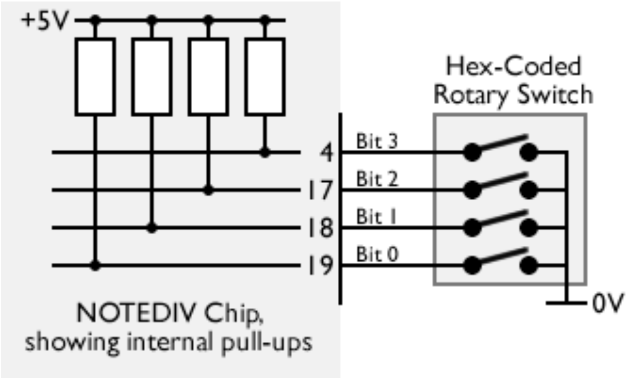
The Note Select inputs (Bits 0-3) use internal pull-up resistors in the chip. Consequently, it is only required to ground pins that should be zero. **Note that the NOTE SELECT pins are only read once at power up.** Changing them whilst the chip is running has no effect. They are intended to configure the chip, not to provide dynamic note selection.

The table below shows the required connections for the four NOTE SELECT inputs for each note.

Number	Binary	NOTE SELECT inputs				Division Ratio	Note
		Bit 3 (Pin 4)	Bit 2 (Pin 17)	Bit 1 (Pin 18)	Bit 0 (Pin 19)		
0	0000	Gnd	Gnd	Gnd	Gnd	÷478	Low C
1	0001	Gnd	Gnd	Gnd	NC	÷451	C# / Db
2	0010	Gnd	Gnd	NC	Gnd	÷426	D
3	0011	Gnd	Gnd	NC	NC	÷402	D# / Eb
4	0100	Gnd	NC	Gnd	Gnd	÷379	E
5	0101	Gnd	NC	Gnd	NC	÷358	F
6	0110	Gnd	NC	NC	Gnd	÷338	F# / Gb
7	0111	Gnd	NC	NC	NC	÷319	G
8	1000	NC	Gnd	Gnd	Gnd	÷301	G# / Ab
9	1001	NC	Gnd	Gnd	NC	÷284	A
10	1010	NC	Gnd	NC	Gnd	÷268	A# / Bb
11	1011	NC	Gnd	NC	NC	÷253	B
12	1100	NC	NC	Gnd	Gnd	÷239	High C

NC = "Not connected"

Setting Note Select from 13 to 15 will give High C, exactly as if the input given was 12. Leaving all pins unconnected gives a setting of 15, so High C is produced.



An alternative to hard-wiring the NOTE SELECT pins would be to use a hex-coded rotary switch to select the input. This is easy to do and might be useful in some situations.

Underclocking Possibilities

The PIC processor used to create the NOTEDIV chip can be run at any speed up to its maximum. It is this feature which allows pitch bend or vibrato to be applied to the master clock. But the master clock can also be slowed down, lowering the frequencies produced. This would allow the chip to generate sub-audio pulse and square waves with octave relationships. These could be useful as triggers or modulation signals, with each signal half the rate of the preceding one. Since each signal is a 0-5V logic level, the outputs can easily be switched on or off using AND gates. Other logic gates (OR/XOR) would allow more complex effects.