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DAP 1
Mini-report
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MIDI is one of the most useful concepts in many aspects of music performance and composition. The use of keyboard style MIDI controllers has been expanded to include other forms of controllers including the use of acoustic instruments. The inclusion of pitch to MIDI converters has allowed users to utilize their acoustic instruments with additional MIDI capabilities.

A MIDI keyboard controller does not send an audio signal but a string of MIDI messages. In other words, the keyboard controller does not have strings which are struck by hammers. It measures certain aspects of performance such as velocity and pitch. Acoustic instruments, such as the guitar, require some type of pickup/converter to allow the aspects of its performance to be changed into MIDI data.

A drum pad or drum triggers measure CV (control voltage) between 0 and 5 volts and send Note On/Note off messages. Because of the nature of this controller, in many drum triggers, no pitch detection or conversion is required as would be in the conversion of a string being plucked converted into MIDI data.

MIDI wind controllers, like the Yamaha WX 7, have a mouth piece with a CV to MIDI converter that measures pressure in volts to send a Note On/Note off message which governs how long to hold the note and when it is starting to die off. It also tells the note velocity of each note. The actual pitch is governed by keys on the controller itself. This is still much different from string based synthesis where a pitch to MIDI converter must be used, not just a CV to MIDI controller.

In order for a guitar to utilize MIDI, a pitch to MIDI converter must be installed. This converter would need to be close enough to the string so that it can detect the string resonance. For this purpose, electric guitars are most common for pitch to MIDI converters because they are already designed with traditional guitar pickup use in mind.

The signal is received in an inverting amplifier. The amplifier feeds it to a circuit which measures the voltage. The wave signal is sent to a microcontroller which uses the wave signal to measure the pitch period of the waveform. [*See attached chart*].

Quality analog guitar pickups can detects the amplitude signal and send it to an amplifier as a mono signal. Squishing all of the MIDI notes into one signal was a problem with MIDI guitars until Roland came up with the idea involving a pitch to MIDI converter for each of the 6 guitar strings. Guitar pickups utilizing this technology are known as HEX pickups. With a HEX pickup, there would also be the need for a MIDI cable capable of transferring this extra data.

The accuracy for the pitch conversion to MIDI is determined by the strength of the signal of the string resonating with regard to the HEX pickup and its pre-amp circuit. This is why a nylon string guitar would not be a good choice for a MIDI pickup since its string resonance is low to begin with. However, a nylon string guitar with an analog pickup running into a midi pickup would be possible, but would most likely be impractical for the mass market.

In a standard 5-pin MIDI cable, pins 1 and 3 are unused. Pin2 is a shield and pins 4 and 5 send the data. HEX pickups utilize 13-pin MIDI date. In a 13 pin MIDI cable, pins 1 through 6 are the six individual outputs of MIDI data from the HEX pickup. The seventh pin is a mix of wires 1 through 6. Pin 8 is MIDI volume which is governed by a separate

MIDI volume switch often installed on the guitar or the pickup. Pin 9 is unused. Pins 10 and 11 select up and down patches and pins 12 and 13 send positive and negative voltage.

Steim, the Studio for Electro Instrumental Music, used to make (out of production) a pitch to MIDI converter sold by itself called SensorLab. Pitch to MIDI converters come installed in the most popular HEX pickups including the Roland GK system and the AIX 101 by Blue Chip.

A MIDI controller can have up to 128 unique MIDI messages to send (0 – 127). A frequency is analyzed and it is named according to a MIDI number instead of the pitch we refer to as musicians. For example, instead of naming a note middle C, it receives a MIDI note number name of Note #60, or, as it appears C5. The 60 refers to the number assigned at the 5th octave of C. this means that the lowest note possible is C, which is numbered at 0. Some software does not consider octave 0 to be the lowest and starts numbering at octave -2. The standard that I've come across most frequently begins the octave at note 0.

Standard Pitch to MIDI Note Number Conversion

Octave	Note Numbers											
	C	C#	D	D#	E	F	F#	G	G#	A	A#	B
0	0	1	2	3	4	5	6	7	8	9	10	11
1	12	13	14	15	16	17	18	19	20	21	22	23
2	24	25	26	27	28	29	30	31	32	33	34	35
3	36	37	38	39	40	41	42	43	44	45	46	47
4	48	49	50	51	52	53	54	55	56	57	58	59
5	60	61	62	63	64	65	66	67	68	69	70	71
6	72	73	74	75	76	77	78	79	80	81	82	83
7	84	85	86	87	88	89	90	91	92	93	94	95
8	96	97	98	99	100	101	102	103	104	105	106	107
9	108	109	110	111	112	113	114	115	116	117	118	119
10	120	121	122	123	124	125	126	127				

As you can see, the range of a standard MIDI controller is C0 to G10 (these are notes zero to note 127). The circuit that measures the waveform to determine its pitch length operates according to this chart. The circuit identifies the frequency and assigns it to a MIDI note number. Please note that A C# is a few cents higher than a Db. A cellist can certainly make these adjustments, but a MIDI system quantizes the pitch upon conversion. A conversion chart is listed below.

MIDI Note Number to Frequency Conversion

chart shows MIDI Note Name/Number and equivalent frequency in all 10 octaves

Octave 0

C	0	8.175798916
Db	1	8.661957218
D	2	9.177023997
Eb	3	9.722718241
E	4	10.30086115
F	5	10.91338223
Gb	6	11.56232571
G	7	12.24985737
Ab	8	12.9782718
A	9	13.75
Bb	10	14.56761755
B	11	15.43385316

Octave 1

C	12	16.35159783
Db	13	17.32391444
D	14	18.35404799
Eb	15	19.44543648
E	16	20.60172231
F	17	21.82676446
Gb	18	23.12465142
G	19	24.49971475
Ab	20	25.9565436
A	21	27.5
Bb	22	29.13523509
B	23	30.86770633

Octave 2

C	24	32.70319566
Db	25	34.64782887
D	26	36.70809599
Eb	27	38.89087297
E	28	41.20344461
F	29	43.65352893
Gb	30	46.24930284
G	31	48.9994295
Ab	32	51.9130872
A	33	55
Bb	34	58.27047019
B	35	61.73541266

Octave 3

C	36	65.40639133
Db	37	69.29565774
D	38	73.41619198
Eb	39	77.78174593
E	40	82.40688923
F	41	87.30705786
Gb	42	92.49860568
G	43	97.998859
Ab	44	103.8261744
A	45	110
Bb	46	116.5409404
B	47	123.4708253

Octave 4

C	48	130.8127827
Db	49	138.5913155
D	50	146.832384
Eb	51	155.5634919
E	52	164.8137785
F	53	174.6141157
Gb	54	184.9972114
G	55	195.997718
Ab	56	207.6523488
A	57	220
Bb	58	233.0818808
B	59	246.9416506

Octave 5

C	60	261.6255653
Db	61	277.182631
D	62	293.6647679
Eb	63	311.1269837
E	64	329.6275569
F	65	349.2282314
Gb	66	369.9944227
G	67	391.995436
Ab	68	415.3046976
A	69	440
Bb	70	466.1637615
B	71	493.8833013

Octave 6

C	72	523.2511306
Db	73	554.365262
D	74	587.3295358
Eb	75	622.2539674
E	76	659.2551138
F	77	698.4564629
Gb	78	739.9888454
G	79	783.990872
Ab	80	830.6093952
A	81	880
Bb	82	932.327523
B	83	987.7666025

Octave 7

C	84	1046.502261
Db	85	1108.730524
D	86	1174.659072
Eb	87	1244.507935
E	88	1318.510228
F	89	1396.912926
Gb	90	1479.977691
G	91	1567.981744
Ab	92	1661.21879
A	93	1760
Bb	94	1864.655046
B	95	1975.533205

Octave 8

C	96	2093.004522
Db	97	2217.461048
D	98	2349.318143
Eb	99	2489.01587
E	100	2637.020455
F	101	2793.825851
Gb	102	2959.955382
G	103	3135.963488
Ab	104	3322.437581
A	105	3520
Bb	106	3729.310092
B	107	3951.06641

Octave 9

C	108	4186.009045
Db	109	4434.922096
D	110	4698.636287
Eb	111	4978.03174
E	112	5274.040911
F	113	5587.651703
Gb	114	5919.910763
G	115	6271.926976
Ab	116	6644.875161
A	117	7040
Bb	118	7458.620235
B	119	7902.132835

Octave 10

C	120	8372.01809
Db	121	8869.844191
D	122	9397.272573
Eb	123	9956.063479
E	124	10548.08182
F	125	11175.30341
Gb	126	11839.82153
G	127	12543.85395

available at vjmanzo.com