User Manual

Hardware Version D
Firmware Version 1.1
August 5, 2010
Kilpatrick Audio

Introduction

Welcome to the wonderful world of the K4815 Pattern Generator. The K4815 is a unique and flexible way of generating notes, rhythms and modulation voltages or control changes. The user interacts with the machine to set the patterns using an unconventional method which works well to find new grooves and musical inspiration. It is a perfect performance tool, a source of notes for jamming, or a way to creating voltages synchronized to a common clock. This manual will explain the features and operation of the unit. Please check for updates to the documentation and firmware often as new features may be added at users' request. We continually strive to advance our products for your benefit and enjoyment.

Features

- Eurorack form factor with 20HP width
- Musical note, control and clock signals generated using unique methods
- 64 LED (8x8) multi-brightness grid to show patterns and status
- Clock control via internal clock, or external MIDI or analog clock
- Clock, Direction and Reset inputs (0V / 5V = off / on)
- CV/GATE or X/Y analog outputs (-5V to +5V range)
- CV is 1V/octave – 10 octave range
- GATE is 0V or 5V
- X/Y outputs are -2.5V to +2.5V (can be shifted beyond this range)
- Internal MIDI header compatible with other Kilpatrick Audio MIDI modules
- MIDI implementation with send/receive capability for full MIDI integration
- Only 30mm deep (including ribbon cables)
- Requires +/-12V (less than 10mA) and +5V (less than 65mA) – 16 pin Doepfer-style power connection required (included)

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Installation and Setup

The K4815 Pattern Generator supports both MIDI and control voltage/gate/clock signals. To use the MIDI function requires the use of a MIDI adaptor such as the K1600 MIDI Converter. But the K4815 can be used by itself without any MIDI devices by using the analog inputs and outputs.

When installing the K4815 in your modular system, pay close attention to the pinout and direction of the 16-pin power input cable. As 5V is required, the 10-pin style of power cable is not compatible. If the cable is backwards or offset your K4815 may be damaged. **This is not covered by the warranty.** If you are using the module with the K1600 or similar MIDI Converter, attach the 10 pin ribbon cable supplied with the K1600. In this case also observe the correct pinout.

Warning: DO NOT plug the MIDI cable into the power port, or vice versa.

Output Voltage Trim

The voltage trim on the outputs is factory calibrated into a 100K ohm load. But depending on your setup you might need to adjust it if the scale tuning is wrong with your oscillators. The multi-turn trim pot supplied on each output can adjust the tuning over a significant range.

To trim the outputs it is required to place a jumper on the MIDI header temporarily to make the unit enter TEST mode. Some MIDI Converters such as the K1600 have a way to turn on the TEST mode. However this mode can be enabled by placing a jumper (supplied) across pins 3 and 5 on the MIDI port as shown below.

When in TEST mode the display will show a "T" on the foreground of the screen to warn you that TEST mode is active.
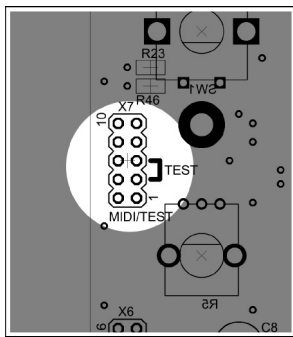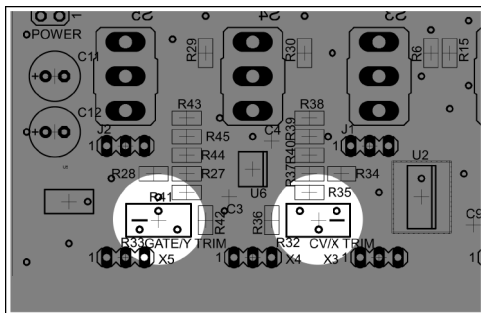

Test Jumper

Test Jumper:

Place a jumper over pins 3 and 5 (ships with jumper across pins 1 and 3) to activate TEST mode. CV/X and GATE/Y outputs will produce +1.000V for testing.

Place the jumper across pins 1 and 3 when not in use.

Output Voltage Trim

Output Voltage Trim:

Adjust the output voltage trim with a small flat screwdriver to achieve the correct scale span with your VCO.

R32 = CV/X trim
R33 = GATE/Y trim

When TEST mode is active, the CV and GATE outputs will generate +1.000V. Measure the voltage with a voltmeter. Adjust the pot for each output until you read exactly +1.000V. Notes should play perfectly in tune across the entire range. If this is not so, adjust the voltage to be higher (larger scale span) or lower (smaller scale span) until you arrive at the correct setting.

Physical Installation

You should install the unit in your modular system using all four screw holes. The unit is designed to be mounted properly to avoid damage to the internal parts when plugging or unplugging cables, or adjusting the controls.

Connection Warnings

The CLOCK IN, DIR IN and RESET IN are designed for 0V (off) and +5-10V. (on) Any voltage over approx. +2V should enable each input. The inputs are tolerant (ver. D and later only) of any voltage from -12V to +12V so you can safely input LFOs and other AC signals.

The CV/X and GATE/Y outputs are analog outputs driven by amplifiers. They have a low output impedance and thus should not be driven by external sources. Please use them as outputs only, and mix them using proper buffered mixing circuits and not by passive multiples or Y-cords. They are short-circuit protected but may be damaged by the external input of voltages. **Do not short the outputs or connect them to any other source of voltage!**

First Use

Connect the CV and gate outputs to a VCO CV input and an envelope generator gate input and let's make some sound! The K4815 has a built-in clock generator so you can create patterns without any external clock source. Flip the INT/EXT switch up to use the internal clock mode. If no external clock is supplied, the CLOCK INT/EXT switch acts as a start/stop control. The CLOCK SPEED control affects the tempo when in internal clock mode. The CLOCK LED pulsates once per beat. Note that in internal clock mode, the notes operate at 4x the clock rate. (16th notes) In the external mode this is adjustable, as you will see later. Make sure the CV/GATE / X/Y switch is up. (CV/GATE mode)

Choose a motion type by turning the MOTION TYPE knob. This selects the motion of the playback ball. Turn up the MOTION LENGTH knob to maximum to play every step in the motion sequence. Adjust the pattern type with the PATTERN TYPE knob to select where notes will play. You should hear notes being generated as the playback ball lands on active notes on the grid. Using the MAJ / MIN and LARGE / SMALL switches, you can choose from major or minor tonalities, as well as large and small output spans. The GATE TIME knob affects how long each note plays, and the MOTION LENGTH knob affects how many of the up to 64 steps in each motion sequence will play before repeating.

Play around with the controls and hear some of the different possibilities. The next section will cover each control in more detail, as well as a more overall discussion of how the K4815 makes patterns based on the settings that you have selected.

Pattern Generation Concept
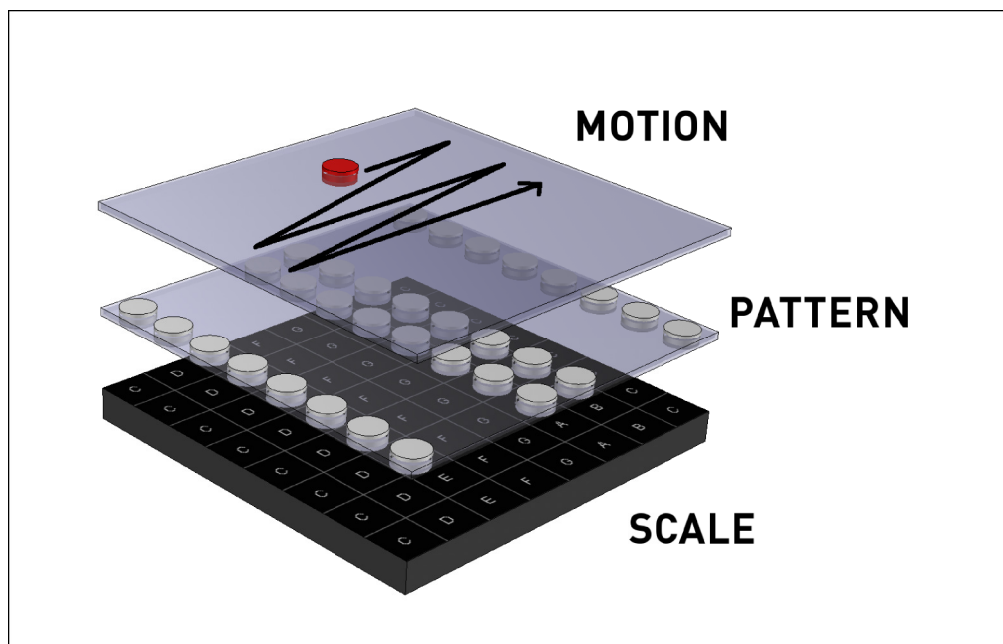
The pattern generator concept employed in the K4815 is one that can be thought of as three separate layers of control. The layers are as follows:

- **Scale –** The scale is the very lowest layer. The notes mapped to each location on the 8x8 grid are set by the chosen scale. Where in most sequencers the notes are assigned by the user, the K4815 fixes the notes to the grid locations. You can choose either major or minor tonality, as well as large or small scale span. This may seem like a limitation, but it's not as you will soon see. The scale mappings are shown below.

- **Pattern Type –** The pattern is set with the PATTERN TYPE control and is shown on the background of the LED grid at all times. It defines which notes on the grid will play as the playback ball moves around the display. If a note is lit, it will play. The pattern defines the overall sound of playback, and can also affect how sparse or dense the pattern is.

- **Motion Type –** The motion is set with the MOTION TYPE control. The motion type defines how the playback ball will move around the grid during playback. A motion contains up to 64 steps, each of which can move to any position on the 8x8 grid. If the ball lands on a grid location which is lit by the pattern, the underlying scale note will play, otherwise the previous note will keep playing. (depending on the GATE TIME setting) The combination of settings for the motion type and pattern type offers an incredible array of rhythmic and melodic sequences.

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Advanced Operation

To provide more in-depth detail of the controls and how to make the most of the machine, this section goes into detail on each aspect of the system.

Internal Clocking and Timing

Using External Clock

The machine uses a 24ppq internal timebase. The clock can be supplied by MIDI timing ticks, by an analog (+5V or greater) clock input signal, or by the internal clock generator. The analog clock triggers on the rising edge and can support clock rates up to approx. 100pps. (250bpm) Each clock pulse input accounts for 1/24th of a beat. When using external clock mode you can adjust how many clock pulses are required to advance the pattern one step. These are set by the CLOCK SPEED pot and range from 1-24 pulses per step. The supported divisions allow: 1, 2, 3, 4, 6, 8, 12 or 24 notes per beat. (24 ticks) The division is only changed at the end of a beat (24 internal counts) to prevent jumpy behaviour.

When external clocks are input either by MIDI or by the analog clock input, MIDI clock pulses are transmitted on the internal MIDI header. In this way you can convert analog clock signals to MIDI signals.

Note: Using MIDI and analog clock at the same time may produce undesired results.

To prevent stuck notes in the case of external clock loss, playing notes are automatically killed if no clock signals are received for 5 seconds. This means that extremely slow tempos of less than 0.5bpm are not supported. (You might require caffeine if this is the tempo of your piece!)

Using Internal Clock

When using the internal clock mode, the CLOCK SPEED pot sets the tempo. In this mode the pattern always advances four steps per beat. (16th notes) The tempo generated by the internal clock can range from approx. 19 to 400bpm. When using the internal clock mode, MIDI clock is automatically transmitted. If the CLOCK SPEED pot is turned all the way down the clock will be stopped.

Clock LED

The clock LED will pulse for a short time at the beginning of every beat. (every 24 clock ticks)

GATE TIME Control

When notes are played, the GATE TIME control affects how long the notes will play. When in the minimum setting, the note will play for 1 internal clock tick. At the maximum setting, the note can play for more than two full beats. Note that this control scales automatically with the tempo. Some

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synthesizer patches might be barely audible if the gate time is short and the tempo is high.

FWD/REV Control and DIR Input

While any motion is playing, the direction can be reversed by adjusting the FWD/REV switch. It can also be reversed by an external voltage. If +5V or greater is placed on the DIR IN jack, the current direction of the pattern will be reversed. The direction can also be changed by using the MIDI CC #64. (damper pedal) When the damper is pressed down, the direction will be reversed.

RESET Control and Input

You can reset the playback position of a motion at any time by pressing on the MOTION TYPE knob. You can also reset the playback position by inputting a +5V or greater signal on the RESET IN jack. Note that the position is reset only once each time the knob is pressed or the RESET IN input goes high. This works even when the clock is stopped. The next note to play after resetting when the clock resumes will be the first note in the pattern. This is similar to the "reset to 16th note" on some sequencers, however in this case the effect is the same without requiring any special settings.

Output Mode via the CV/GATE / X/Y Switch

Normally the CV/GATE / X/Y switch is in the CV/GATE mode (up). In this mode notes are generated as CV and GATE on the output jacks, and MIDI note messages are sent on the MIDI bus. In the X/Y mode (down), the CV and GATE jacks output signals which are related to the absolute playback ball position on LED matrix. This can be used for modulation or other uses varying voltages. The X output sends the horizontal position and the Y output sends the vertical position. The MIDI output sends continuous controller (CC) messages for the X and Y positions also. These are shown in the MIDI Implementation section of the manual. Note that the outputs in X/Y mode are stepped and if you want continually varying voltages you will need to pass them through a glide processor.

MAJ/MIN and LARGE/SMALL Switches

The underlying notes which are used for playback are selected with the MAJ/MIN and LARGE/SMALL switches. As the melodic and rhythmic patterns are based on a wide variety of patterns and motions, the underlying notes are kept purposefully simple. The MAJ/MIN switch chooses major (up) or minor (down) scales. The minor scale used is the natural minor. The LARGE/SMALL switch affects how many octaves are mapped onto the grid. In the small mode (down) there are two octaves. In the large mode (up) there are four octaves.

In the X/Y output mode the LARGE/SMALL control affects the size of the output signal. Either small (down) or large (up) range of control. Experiment with the outputs on either analog or MIDI to see how this affects your other equipment. The MAJ/MIN switch inverts both the X and Y signals in case you wish to have an opposite voltage output.

Major Scale

The major scale spans from C to C without any output offset applied. Notes are mapped from left to right on each row. Every column has the same notes, but different octaves depending on the setting on the LARGE/SMALL switch.

Minor Scale

The minor scale spans from C to C without any output offset applied. The natural minor is used. (flattened third, natural 6th and 7th) Every column has the same notes, but different octaves depending on the setting on the LARGE/SMALL switch.

Large Span

In the large span mode, four octaves are used. These go from low on the top row, to high in the fourth row. The scales then repeat on the lower half of the grid.

Small Span

In the small span mode, two octaves are used. The lower octave is on rows 1, 3, 5 and 7. The higher octave is on rows 2, 4, 6 and 8.

Scale Mapping (All Modes)

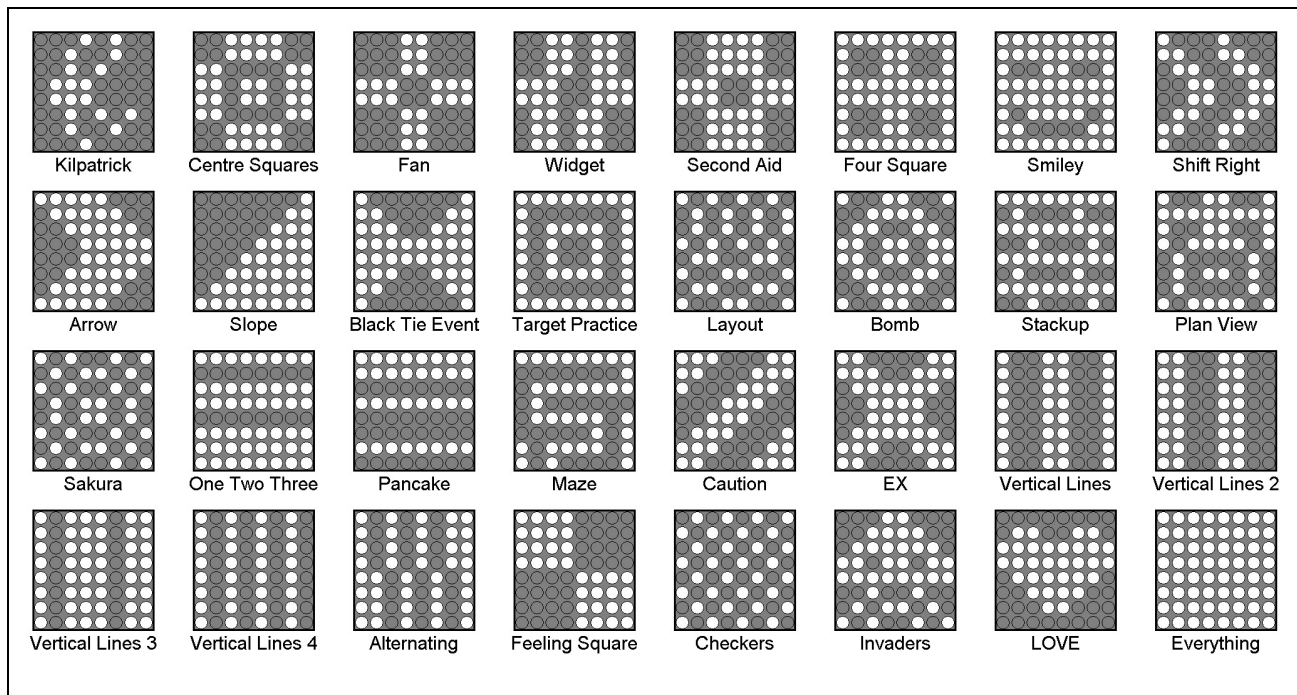| C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C
C	D	E	F	G	A	B	C

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OUTPUT OFFSET Control

In CV/GATE mode, the OUTPUT OFFSET control affects the transposition of the note outputs on CV and MIDI. You can shift the notes up or down by semitones. A full 10 octave range is possible.

In X/Y mode, the OUTPUT OFFSET control affects the DC offset of the X and Y signals. You can use this control to get the varying signal into the right range for your equipment. The span of the X/Y output is -2.5V to +2.5V, so you can shift this up and down. This control does not affect the MIDI CC outputs of the X/Y signal which always outputs the full 7 bit MIDI controller value range.

PATTERN TYPE Control

The PATTERN TYPE control selects from one of 32 internal patterns which display on the background of the LED matrix and determine which of the underlying scale notes will play when the playback ball lands on them. There is a range of geometric and other special patterns to choose from, all of which provide different kinds of notes and rhythms depending on the motion type used. There is also a pattern with every note enabled which may be useful for testing and hearing different motion patterns and scales in their entirety.

Kilpatrick	Centre Squares	Fan	Widget	Second Aid	Four Square	Smiley	Shift Right
Arrow	Slope	Black Tie Event	Target Practice	Layout	Bomb	Stackup	Plan View
Sakura	One Two Three	Pancake	Maze	Caution	EX	Vertical Lines	Vertical Lines 2
Vertical Lines 3	Vertical Lines 4	Alternating	Feeling Square	Checkers	Invaders	LOVE	Everything

MOTION TYPE Control

The MOTION TYPE control affects how the playback ball moves around on the display. Each motion type can have up to 64 steps. Each of these steps can land on any position on the grid, and positions can be visited twice, so quite complex motions are possible, not just sequential patterns. There are 64 motion types which are selected by using the MOTION TYPE control. Pressing on the control resets the motion playback position to the first step.

When you change motion types, the selected motion is shown on the display briefly in the form of two intersecting lines. The horizontal line represents the row, and the vertical line represents the motion number from 1-8 along that row. This allows all 64 motions to be shown by the intersection of two lines on the grid.

The MOTION TYPE can also be set via MIDI program change. Patches 1-64 select the 64 motions available from the front panel of the machine. Patches 65-128 select the same patches but in "key trigger" mode, meaning that the motion will only play when MIDI note messages are received (keys pressed) on a MIDI keyboard. This allows the machine to work as an auto-arpeggiator.

There are some special motion types which are not pre-programmed, but instead are set randomly. These allow either continually changing random motions, or random motions which are seeded each time the motion is selected, so that repetition of the motion is possible.

Preset Motions

Preset motions are available from patches 1-48. These are hand-generated by several collaborators and contain simple linear motions, as well as more complex motions. Motions are up to 64 steps long, but some are less than this based on the particular design concept. Some are visually designed and others are musically designed, taking into account the underlying scale notes to create melodic and arpeggiating patterns.

Random Motions

In addition to the 48 preset motions, there are also 16 random motion types in locations 49-64. These are algorithmically created in real-time using a pseudo-random number generator. There are two random motion types with up to eight variations possible for each. See the list below for the variation types.

- **Seeded Random** – All 64 possible steps are seeded with random values once. Subsequent playback causes the same motion to be repeated.
- **Totally Random** – Each motion step is generated new every time. This creates a constantly changing random sequence.

Motion List

1 - Sequential left to right and top to bottom.	33 - E-C-C-G Triads
2 - Sequential top to bottom and left to right.	34 - F-D-A Triads
3 - Sequential zig zag left/right from top to bottom.	35 - The Sound of Five
4 - Sequential zig-zag up/down and from left to right.	36 - Slither
5 - Jumping from the start.	37 - Mini Slither
6 - Crazier jumping from the start.	38 - Mini Slither 2
7 - Spiral	39 - Crossing Over
8 - Diagonal zig-zag from bottom left corner.	40 - Groove 1
9 - Skipping zig-zag from bottom right corner.	41 - Groove 2
10 - Up and down triads.	42 - Groove 3
11 - Octave jumping 5ths.	43 - Groove 4
12 - Octave jumping wiggly worm.	44 - Groove 5
13 - Octave jumping rows of four.	45 - Groove 6
14 - Wiggles in different directions.	46 - Groove 7
15 - Preset scatter 1.	47 - Groove 8
16 - Preset scatter 2.	48 - Groove 9
17 - Preset scatter 3.	49 - Seeded Random - Seconds
18 - Ping-pong horizontal mirror reflection.	50 - Seeded Random - Thirds
19 - Cat.	51 - Seeded Random - Fifths
20 - Hanon.	52 - Seeded Random - Row 1
21 - Diagonal zig-zag from bottom right corner.	53 - Seeded Random - Rows 1 and 2
22 - Diagonal zig-zag ping-pong from bottom right corner.	54 - Seeded Random - 1, 2, 3 and 4
23 - X circle	55 - Seeded Random - 1, 2, 5 and 6
24 - Stars.	56 - Seeded Random - All Notes
25 - Ropes and knots.	57 - Totally Random - Seconds
26 - Squares of different sizes.	58 - Totally Random - Thirds
27 - Hurricane shape.	59 - Totally Random - Fifths
28 - C-E-G Triad	60 - Totally Random - Row 1
29 - D-F-A Triad	61 - Totally Random - Rows 1 and 2
30 - C-E-G-B Triad	62 - Totally Random - 1, 2, 3 and 4
31 - D-F-A-C Triad	63 - Totally Random - 1, 2, 5 and 6
32 - C-E-G-C Triads Up/Down	64 - Totally Random - All Notes

MOTION LENGTH Control

Each motion type can have up to 64 steps. But it can sound interesting to play fewer steps. By turning down the MOTION LENGTH control you can play from 1-64 of the total steps in the motion. The motions will repeat once the end of the motion (or the current length setting) is reached.

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MIDI Implementation

In addition to analog interfaces available from the front panel, the K4815 fully supports MIDI and provides a number of useful functions that are not available on the front panel. It also provides a useful MIDI clock output which can be used as either a stand-alone MIDI clock generator, or as an analog (5V) clock to MIDI converter.

It also provides clock input via MIDI clock, which can be used instead of the analog clock input. Control change and note outputs are supported, as well as note and controller input for transposing the pattern, using key trigger playback mode, and reversing the direction of playback.

MIDI Hardware Interface

On the back of the K4815 PCB is a 10 pin header labelled as MIDI/TEST. It contains MIDI TX and RX signals, +5V output, as well as a test pin which places the machine in test mode when jumpered to ground. You can access the MIDI signals via a compatible Kilpatrick Audio MIDI module, or by building your own MIDI interface to attach to the 10 pin connector. Since power is supplied, you can use a single cable to connect a simple MIDI interface, with no main power supply connection required. Note that the signals on the MIDI header are 5V TTL signals and cannot be interfaced directly to MIDI cables without some simple circuitry. Please see the Kilpatrick Audio website for free information about building your own MIDI interface.

MIDI Clock Support

By sending MIDI clock to the machine while it is in external clock mode, it is possible to synchronize the machine to an external MIDI sequencer or other clock source. The input is divided by the CLOCK SPEED control just as with an analog clock input.

When running in any clock mode, MIDI clock is sent to the MIDI output. This means that the machine can be used as a MIDI clock generator (internal clock), or an analog to MIDI clock converter.

MIDI Program Change

The 64 motion types can be selected by a MIDI program change command received by the machine. Programs 1-64 correspond to the 64 patterns selectable by the MOTION TYPE control. Programs 65-128 correspond to the same 64 patterns, except that keyboard trigger mode is enabled. Keyboard trigger mode allows the playback of a motion to be started when a key is pressed, to use the K4815 as a sort of auto-arpeggiator.

MIDI Note Support

When in CV/GATE output mode, MIDI notes corresponding to the ones being sent from the CV and gate

outputs will be sent. The note length and transposition are the same as the analog outputs.

Notes received by the machine from an external MIDI keyboard will transpose the currently playing notes. Middle C is treated as the default transposition. Any notes higher or lower will shift the note playback by the corresponding number of semitones away from middle C.

When one of the patches from 65-128 are selected, notes received by the K4815 will trigger the start of playback at the beginning of the motion sequence. If you play legato, the notes will be transposed, but the motion will continue playing through to the end before repeating. If you play staccato, the motion will restart from the beginning for each note.

MIDI Controller Change

While in X/Y output mode, instead of transmitting MIDI notes, continuous controller messages will be sent. Controllers 16 and 17 correspond to the X and Y values of the playback ball respectively. The LARGE/SMALL switch affects the size of the output, and the MAJ/MIN affects the polarity of the output voltages.

When MIDI controller 64 (damper pedal) is received the current playback direction is reversed just as with the analog DIR input.

MIDI SYSEX Messages

A series of SYSEX messages are used for software updating and loading new motions, patterns and scales. Currently this requires software from Kilpatrick Audio and will be sent to owners of the K4815 who request additional or different features or require bug fixes. Please contact Kilpatrick Audio for more information if you would like to experiment with this feature.

Internal Connector Pinouts

To assist in making correct connections, and to aid in the creation of compatible adaptor circuits, the internal pin headers are documented here. Please note that X8 is a factory setup connector only and should not be used. Both X6 and X7 connectors are 0.100" pitch pin headers. Standard IDC ribbon cables can be connected.

```
        X7
   10 |o o| 7
    8 |o o| 5
    6 |o o| 5
    4 |o o| 3
    2 |o▣| 1
   MIDI/TEST


        X6
   16 |o o| 15
   14 |o o| 13
   12 |o o| 11
   10 |o o| 9
    8 |o o| 7
    6 |o o| 5
    4 |o o| 3
    2 |o▣| 1
     POWER
```
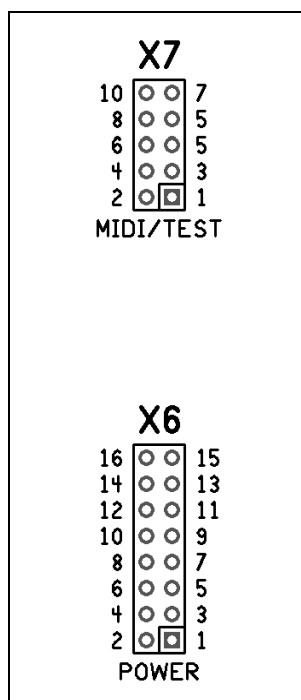
X7 – MIDI/Test Connector:

1. GND
2. GND
3. GND
4. GND
5. TEST (ground to activate)
6. MIDI RX (input)
7. N/C
8. MIDI TX (output)
9. +5V output (100mA max.)
10. +5V output (100mA max.)

Notes:
- MIDI RX and TX use 5V TTL signal levels. External MIDI interface circuitry is required.
- MIDI RX is internally terminated to +5V with a 10K resistor.

X6 – Power:

1. -12V input
2. -12V input
3. GND
4. GND
5. GND
6. GND
7. GND
8. GND
9. +12V input
10. +12V input
11. +5V input
12. +5V input
13. N/C
14. N/C
15. N/C
16. N/C

Support and Additional Information

Please contact Kilpatrick Audio with additional questions about the K1600 MIDI Converter. We will do our best to help you make the most of your MIDI converter and welcome your suggestions as to software improvements or ideas for features on new products. Contact: info@kilpatrickaudio.com

K4815 Pattern Generator   **MIDI IMPLEMENTATION CHART ver.1.0**   **2010-05-14**

Function		Transmitted	Recognized	Remarks
Basic **Default**		1 (default)	1 (default)	Use TEST mode to set
Channel **Changed**		1-16 (configured)	1-16 (configured)	the MIDI RX channel.
Mode	**Default**	X	X	
	Messages	X	X	
	Altered	X	X	
Note Number		0-127	0-127	
Velocity		O	O	
After **Keys**		O	O	Echoed from input
Touch **Ch's**		O	O	
Pitch Bend		O	O	Echoed from input
Control Change		O	O	
		16 = X output	64 = DIR input	
		17 = Y output		
Prog		X	0-127	Upper bank has "key
Change **True #**			0-63 / 0-63	trigger" enabled.
System Exclusive		O	O	During bootup for software update only.
System	**Song Position**	O	O	
Common	**Song Select**	X	X	
	Tune Request	X	X	
System	**Clock**	O	O	
Realtime	**Commands**	O	X	
Aux	**Local On/Off**	X	X	
Messages	**All Notes Off**	X	X	
	Active Sensing	X	X	
	System Reset	X	X	
Notes		MIDI clock timeout is 5 seconds. Software update specification available upon request. Implemented by Kilpatrick Audio update software as supplied to customers.		

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