Bontempo

Tap Tempo & Modulation for PT2399

Datasheet & Application Note

Introduction:

Bontempo is a Tap Tempo and Modulation integrated solution for PT2399 delay. It controls delay time via a digital potentiometer. A PWM output controls the modulation via a MOSFET.

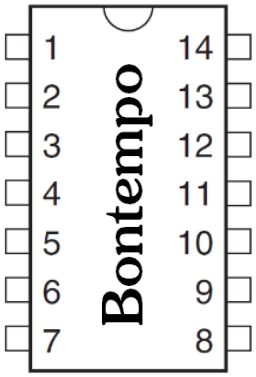
Delay time, modulation speed and depth are fully controllable.

6 Tap Tempo time divisions and 6 modulation waveforms are available. The Bontempo can handle dual PT2399 configurations.

Features:

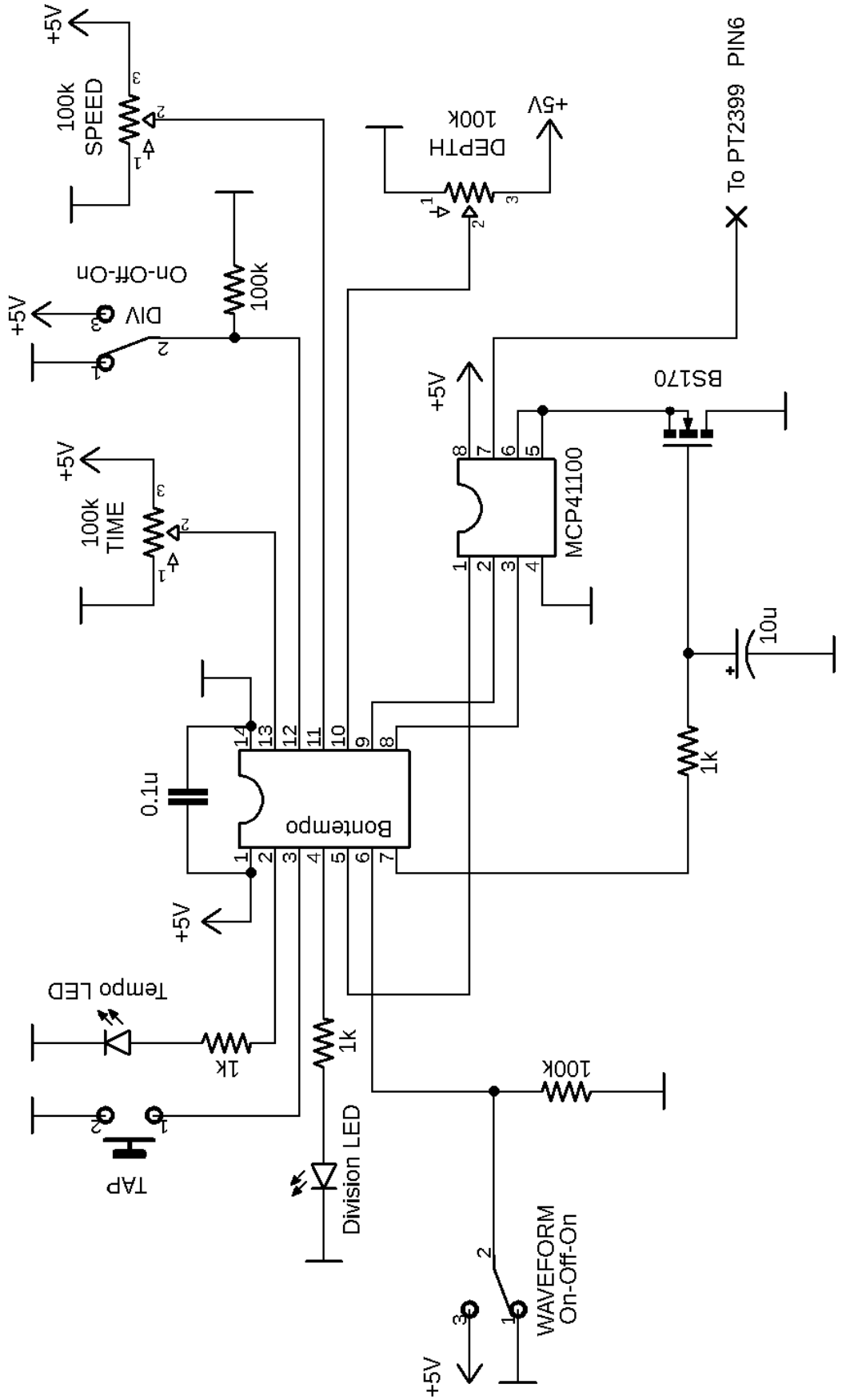
- 8-bit Digital Potentiometer Tap Tempo
- ~40ms to ~1300ms delay time
- Potentiometer Time Control
- 6 Tempo Divisions (♩ , ♪. , ♪ , ♫ , ♬ , 𝅘𝅥𝅯𝅘𝅥𝅯𝅘𝅥𝅯𝅘𝅥𝅯)
- Clean Mode (limits delay to 600ms for cleaner sound)
- Dual PT2399 Mode
- ±30ms Max. Modulation Depth
- ~0.1Hz to ~10Hz Modulation Speed
- 6 Modulation Waveforms (∿ , ⊓ , ⩚ , ◿ , ⩛ , ⎍)
- 2 LED indicators
- Conpact DIP14 package
- Minimal amount of external parts

Pin Configuration :



Pin	Function	Input/Output
1	VCC	I
2	Tempo LED+	O
3	Momentary Tap Button	I
4	Scale LED+	O
5	Digital Potentiometer Chip Select	O
6	Waveform Toggle	I
7	Modulation PWM	O
8	Digital Potentiometer Data	O
9	Digital Potentiometer Clock	O
10	Modulation Depth Potentiometer	I
11	Modulation Speed Potentiometer	I
12	Tempo Division Toggle	I
13	Time Potentiometer	I
14	GND	I

Typical Application Schematic:



Absolute Maximum Ratings:

Storage Temperature	-65°C to +150°C
Operating Temperature	-55°C to +125°C
Voltage on any pin except pin 4	-0.5V to Vcc + 0.5V
Voltage on Pin 4	-0.5V to +13.0V
Maximum Operating Voltage	+6.0V
DC Current per I/O Pin	40.0mA
DC Current VCC & GND pins	200.0mA

DC Characteristics

Parameter	**Min**	**Max**	**Unit**
Power Supply Voltage	2.7	5.5	V
Power Supply Current	4.4	7	mA

For any other DC characteristics please refer to the ATtiny84A datasheet (p.173).

Specifications:

All specifications tested at Vcc = 5V.

Parameter	**Min**	**Max**	**Units**
Delay Time	37	1306	ms
PWM frequency	-	1	kHz
Modulation Frequency	0.12	10.17	Hz
Modulation Depth	0	30	ms
All Potentiometer/Toggle Input	0	5	V

Power Supply:

The chip will operate with a power supply between 2.7V and 5.5V. However, if the modulation is in use, a regulated 5.0V power supply is recommended. This is because the modulated tap tempo was calibrated at 5.0V and a change in Vcc will affect the PWM output voltage.
A 0.1uF capacitor should be connected between Vcc and GND and be placed as close to the pins as possible.

If using the same 5V regulator as the PT2399 be careful that the regulator can handle the extra load, and that the Bontempo is fed a correct voltage.

Clean Mode:

The clean mode limits the maximum tempo to 600ms. This will produce a less distorted delay. This will emulate a 50kΩ time potentiometer, like some PT2399 delay.

To activate the Clean Mode, you need to:

- Make sure the chip is powered down
- Press Tap Button
- Power Up the Bontempo while keeping the Tap Button Pressed
- Keep the button pressed for 4s until the Tempo LED blinks twice
- You now have 2s to release the button, the LED will blink twice again
- You are now in Clean Mode

This status is written in the chip's EEPROM. This mean the Bontempo will boot in clean mode every time.
To deactivate Clean Mode, just repeat the procedure above. The chip will now boot in normal mode every time.

Dual PT2399 Mode:

The Bontempo can interface a MCP41100 as well as a MCP42100 for using two PT2399 in your delay circuit. If you choose to use a MCP42100 or to daisy chain two MCP41100, a problem remains: the delay time is now twice as long.
To remedy to that you can put the Bontempo in Dual PT2399 Mode. This mode will divide the tempo output per 2. This way, the time divisions will stay relevant.

To activate Dual PT2399 Mode you need to:

- Make sure the chip is powered down
- Press Tap Button
- Power Up the Bontempo while keeping the Tap Button pressed
- Keep the button pressed for 10s ignoring the two blinks (which are for Clean Mode) until the Tempo LED blinks four times
- You now have 2s to release the Tap Button, the LED will blink four times again
- You are now in Dual PT2399 mode

This status is written in the chip's EEPROM. This mean the Bontempo will boot in Dual PT2399 Mode every time.

We can assume that this feature will only be toggled once but if any mistakes happen: to deactivate Dual PT2399 Mode, just repeat the procedure above. The chip will now boot in normal mode every time.

Time Potentiometer Input:

This input is to voltage control the delay time. This input will control the delay time until you activate the tap tempo. While the delay time is controlled by this input, the Tempo LED and Scale LED will stay on.
To take back control from the Tap Tempo, you just need to modify this input's voltage by 5%.
Typically, you would use a Potentiometer for the delay time control.

The recommended potentiometer value is 10kΩ or above, to avoid having too much current going through the pin.

You can add a 0.1µF capacitor between the input and ground for smoother time changes.

Digital Potentiometer Interface:

The only digital potentiometer guaranteed to work are the MCP41100 and MCP42100. They are 8bit 100kΩ SPI controlled digital potentiometers. The SPI interface requires 3 pins (Clock, Data and Chip Select). Since the potentiometer is 8bit, it has 256 different wiper positions. This limits the tap tempo precision to approximately 5ms. This imprecision isn't usually noticeable, except with a lot of repetitions on some time settings.
For more information about the digital potentiometers see datasheet.

Please be careful with the connection between the digital potentiometer and the PT2399, as the PT2399 is sensible to noise and this could throw off the calibration. Keep the connection short and direct.

Momentary Tap Tempo Button Input:

This input is only compatible with a momentary switch.
The debounce is handled by software so no extra external components have to be used. Debounce time is 500µs.
The program starts counting after the first press. If the button is not pressed again after a certain time (see below), the timer is reset and the tap sequence is aborted.

Time division selected	Tap Reset Time
	2.1s
	2.5s
	3.4s
	4.7s
	6s
	8.6s

In Clean Mode:

Time division selected	Tap Reset Time
	1.4s
	1.6s
	2s
	2.6s
	3.2s
	4.4s

The Reset Time equation is as follows:

$$\frac{MaxDelay}{DivMultiplier} + 800 = Tap\ Reset\ Time\ (ms)$$

The delay time tapped is in effect right after the second press of the tap button.

After the second press of the tap button, every following tap in the sequence is averaged in order to reach easily the desired tempo.

While the Tap Tempo is active the two LED will blink in sync with the Tempo.

Tempo Division Toggle Input:

Six different tempo division are accessible with this input. To access every time division a SPDT On-Off-On toggle switch is required.

The first three time divisions are fourth, dotted eighth and eighth.

Pin 12 Voltage	Time Division
GND to 0.39V	Fourth ♩
0.4V to 4.4V	Dotted Eighth ♪.
4.5V to 5V	Eight ♪

The last three time divisions are accessed by first pressing the tap button and then changing the toggle position while the tap button is pressed. The press will not count as a press for the tap tempo.

Pin 12 Voltage	Time Division
GND to 0.39V	Triplet ♩♩♩
0.4V to 4.4V	Sextuplet ♬
4.5V to 5V	Four sixteenth ♬

If the time division is changed while the Tap Tempo is active, the delay time will be changed accordingly instantly.

You can access the middle time division by putting a resistor between pin 12 and ground. Any value between 5kΩ and 140kΩ would potentially work, but a 100kΩ resistor is recommended in order not to draw too much current.

Modulation PWM Output:

Modulation on the Bontempo is achieved by outputting a voltage to a BS170 MOSFET in series with the digital potentiometer. The PWM frequency is 1kHz, since this frequency is the audible spectrum, we need to filter it. If a filter is not used it will result in some ring modulation in the modulated delay signal.

The chip is calibrated with a first order filter composed of a 1kΩ resistor and a 10µF capacitor. The 1kHz is reduced by 36dB by this filter, which is sufficient to make de ring modulation inaudible.

Waveform Toggle Input:

Six different modulation waveforms are accessible with this input. To access every waveform a SPDT On-Off-On toggle switch is required.

The first three waveforms are sine, square and triangle.

Pin 6 Voltage	Waveform
GND to 0.39V	Sine
0.4V to 4.4V	Square
4.5V to 5V	Triangle

The last three waveforms are accessed by first pressing the tap button and then changing the toggle position while the tap button is pressed. The press will not count as a press for the tap tempo.

Pin 6 Voltage	Time Division
GND to 0.39V	Ramp Up
0.4V to 4.4V	Ramp Down
4.5V to 5V	Random

The waveforms can sound a bit asymmetrical, this is due to the MOSFET's non-linearity. Like for the Time Division Toggle, a 100kΩ resistor is recommended to access the middle waveform.

Modulation Depth & Speed Potentiometer Inputs:

Same recommendations as the Time Potentiometer (10kΩ or more, 0.1µF capacitor…).

Modulation speed goes from 0.12Hz to 10.17Hz.

Modulation depth maximum is 30ms.

Disabling Modulation:

If you don't wish to use the modulation features just connect PIN 6, PIN 10 and PIN 11 to ground. You can then omit the BS170 MOSFET and the PWM filter.

When booting, the chip will recognize this state and use a different delay calibration. The Delay Time range become 41ms to 1134ms.

The Modulation Disabled state is reevaluated every time the chip is powered on. So, you can gain back access to modulation if you need it.

Tempo LED & Scale LED:

If the delay time is controlled by the Time potentiometer both LEDs will stay on.

When the Tap Tempo is active, the tempo LED will blink in sync with the tempo you tapped. The scale LED will blink in sync with the delay time. In other words, the scale LED is sensible to the time division selected and will blink accordingly.

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