

# Application Note AN-100 InnoSwitch4-Pro Family

## Mini Toggle Board User Guide

### Introduction

The TST-047 enables a set of operating conditions to be programmed into the InnoSwitch4-Pro IC. Once programmed, these settings are stored in a Non-volatile memory and are automatically transferred to the InnoSwitch4-Pro IC whenever the power is cycled. This allows testing of the InnoSwitch4-Pro based power stage without the need for an external microcontroller.

This tool is especially helpful when repeated tests are to be performed such as EMI or safety tests and the InnoSwitch4-Pro based power stage is to be set to a specific operating point. This is useful when conducting

thermal tests or tests where the unit is being modified and there is a need for the InnoSwitch-Pro to get configured with a specific set of parameters after each power cycle.

This manual is a user's guide for the InnoSwitch3-Pro Toggle Board (TST-047). The InnoSwitch3-Pro Toggle Board can be used as a tool to control the InnoSwitch4-Pro power supply. The document describes what constitutes the board, how it works and how to use it with InnoSwitch4-Pro family of devices. It also contains the schematic, bill of materials, printed circuit board layout.

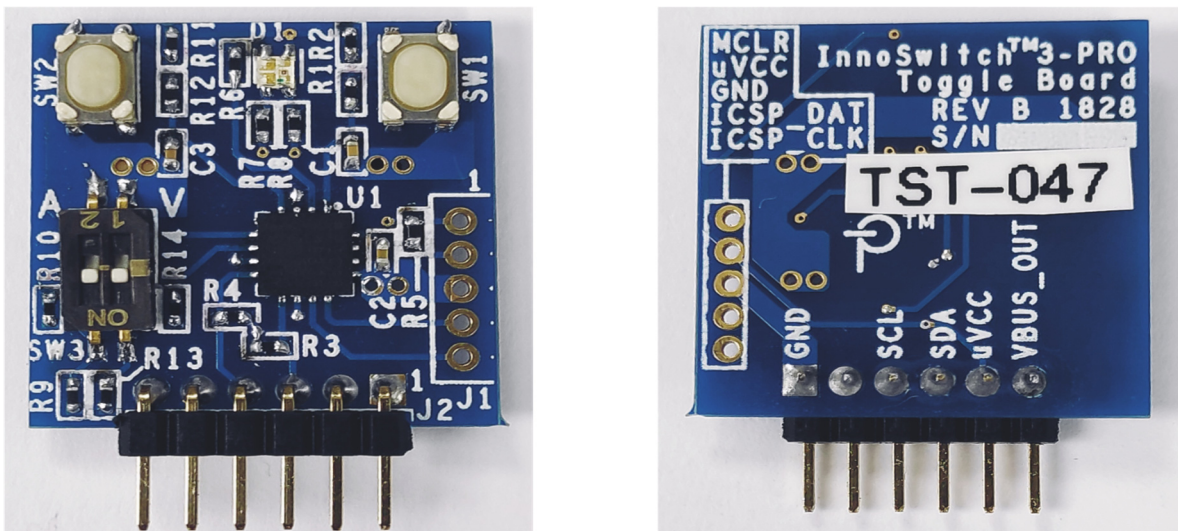


Figure 1. TST-047 Top and Bottom Board

### Board Layout

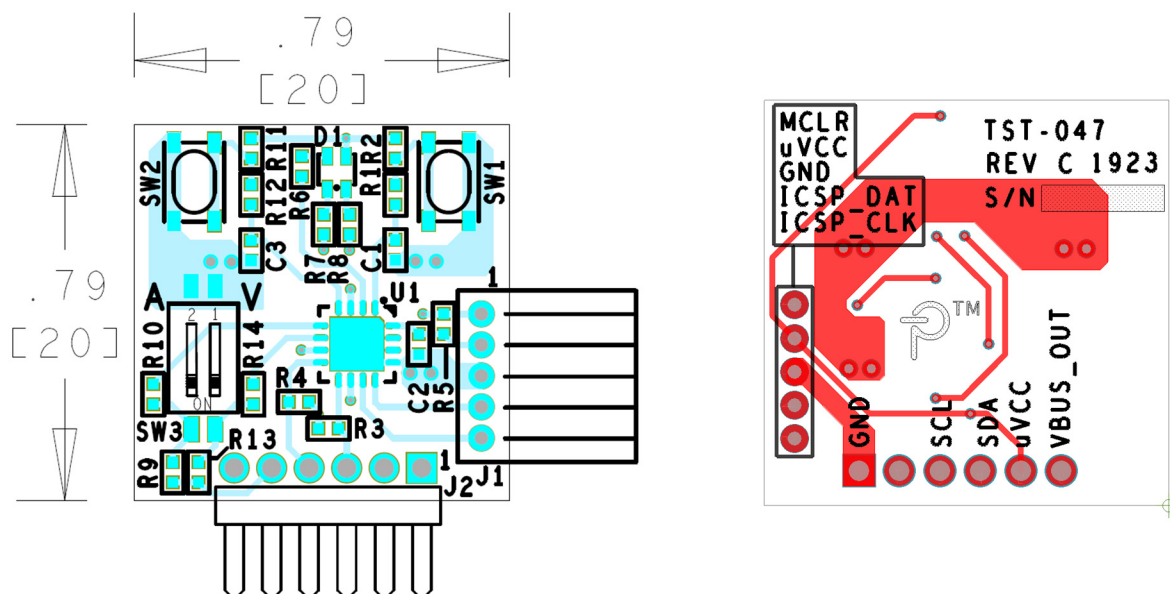


Figure 2. Top and Bottom PCB Layout

Schematic Diagram

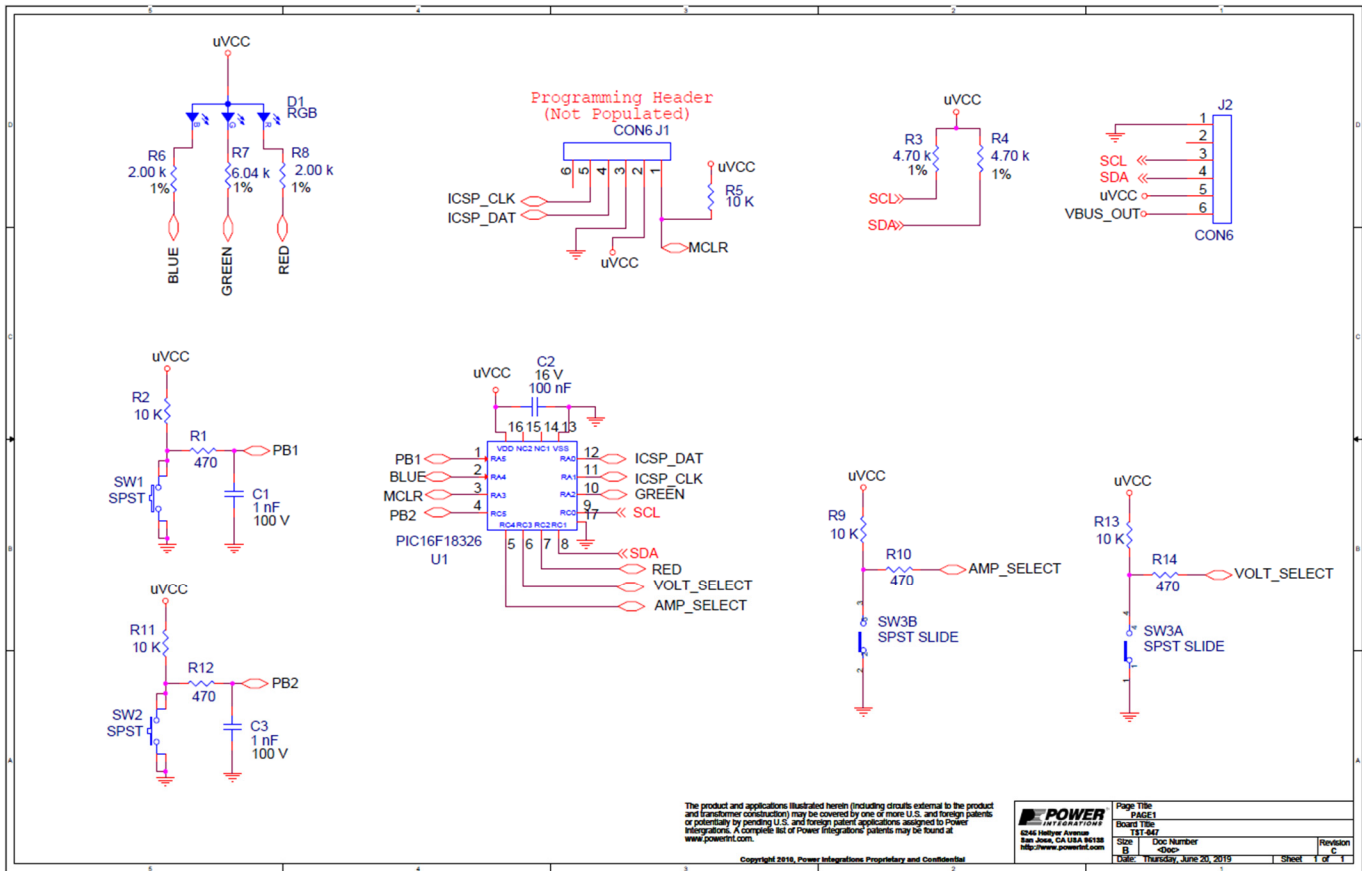


Figure 3. TST-047 Schematic Diagram

Hardware Assembly

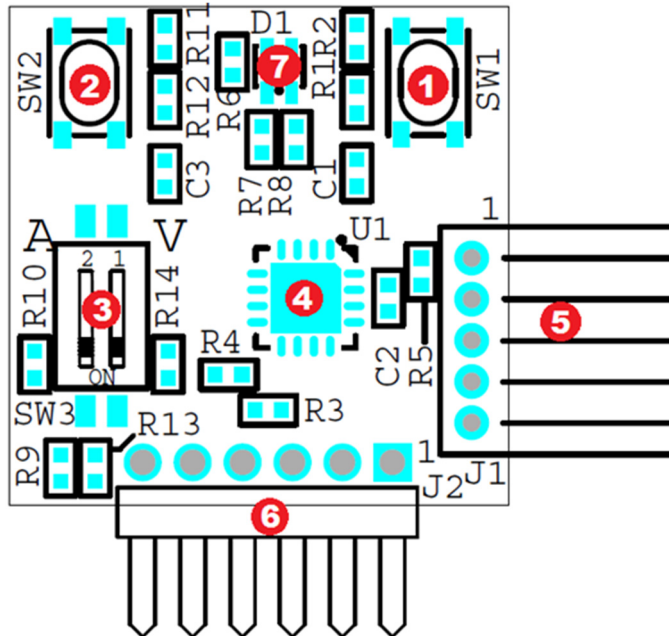


Figure 4. Board Components

The TST-047 features are indicated on the table below

Number	Description	Label
<b>1</b>	Increment Switch	SW1
<b>2</b>	Decrement Switch	SW2
<b>3</b>	CC/CV/VKP Selection Switch	SW3
<b>4</b>	PIC16F18326	U1
<b>5</b>	PICkit3 Programming Header	J1
<b>6</b>	Connector to PSU	J2
<b>7</b>	RGB LED Indicator	D1

Table1. TST-047 Part Functionality

## Functional Description

### Switches

At power ON, any adjustments can be made within the first 5 minutes. A countdown timer will lock the button functionality after its timeout. No request will be processed after 5 minutes even if the buttons were pressed. When the user wants to re-adjust the settings but the buttons

state is already locked, a reset operation will be needed (requires power cycling).

The tables below provide the functions of the switches at different cases:

Push Buttons	CDC	CV	CC	VKP
SW1	+50mV	+1V	+5 LSB	+1V
SW2	-50mV	-1V	-5 LSB	-1V

Table2. Single Click Function based on Adjustment State

The CDC value is set to the maximum value (600mV) when SW1 is double clicked. The value is then set to the minimum value (0mV) when SW2 is double clicked.

Push Buttons	CDC	CV	CC	VKP
SW1	600mV	+200mV	+1 LSB	+200mV
SW2	0mV	-200mV	-1 LSB	-200mV

Table3. Double Click Function based on Adjustment State

Register	Adjustment Range	Default
CDC	0 ~ 600 mV	300 mV
CV	3 ~ 20 V	5 V
CC	25 ~ 192 LSB	192
VKP	5.3 ~ 24 V	24 V

Table4. Register Adjustment Range

### Slide Switch

V and A markings on the PCB correspond to Voltage and Current respectively. The register to be updated is selected based on the setting of the slide switches.

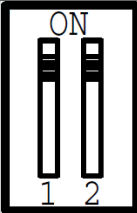
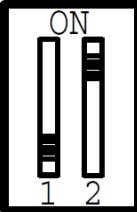
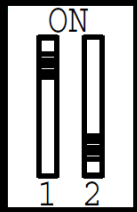
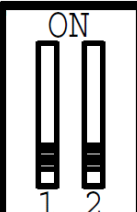
SW3A (V)	SW3B (A)	Switch Configuration	Register Selection	LED Indicator
ON	ON	 Configuration 1	CDC	Blue Green
OFF	ON	 Configuration 2	CV	Red
ON	OFF	 Configuration 3	CC	Green
OFF	OFF	 Configuration 4	VKP	Blue

Table5. Slide Switch States

### LED

LEDs on board provide a better visual indicator of the selected register to update as summarized by the table below.

LED Status	Description
Blinking every 500 ms	Very First Power ON or Reset Configuration
Blue and Green LED On	Cable Drop Compensation (CDC) Update Selected
Red LED On	Constant Voltage (CV) Update Selected
Green LED On	Constant Current (CC) Update Selected
Blue LED On	Constant Output Power Knee Voltage (VKP) Update Selected

Table6. LED Status

### I2C

The Mini Toggle Board communicates with the PSU using I<sup>2</sup>C using the J2 header.

## MCU Signal Configuration

The toggle board has been designed with the following signal configurations on the PIC16F18326.

Signal Label	Pin No	Device Pin Function	Pin Type	Description / Function
<b>PB1</b>	1	RA5	Input	SW1 Push Button
<b>BLUE</b>	2	RA4	Output	LED Blue
<b>MCLR</b>	3	MCLR	Input/Power	Master Clear (Reset) Input
<b>PB2</b>	4	RC5	Input	SW2 Push Button
<b>AMP_SELECT</b>	5	RC4	Input	Constant Current Select (SW3)
<b>VOLT_SELECT</b>	6	RC3	Input	Constant Voltage Select (SW3)
<b>RED</b>	7	RC2	Output	LED Red
<b>SDA</b>	8	RC1	Output	I2C Data
<b>SCL</b>	9	RC0	Output	I2C Clock
<b>GREEN</b>	10	RA2	Output	LED Green
<b>ICSP_CLK</b>	11	RA1	Not Used	Not Used
<b>ICSP_DAT</b>	12	RA0	Not Used	Not Used
---	13	VSS	Power	Ground reference for logic and I/O pins
---	14	NC	---	Not Connected
---	15	NC	---	Not Connected
---	16	VDD	Power	Positive Supply for Peripheral Logic and I/O Pins

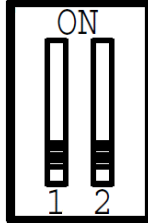
Table7. PIC16F18326 Pin Signals

## Adjustment Instructions

This section provides the step by step instruction on how to operate the board correctly. The button press will be automatically disabled after 5mins and LED **D1** will be off. Leaving the Slide Switch (**SW3**) in configuration 1, 2, or 3 will ensure that the saved settings in the EEPROM will be used upon power cycle.

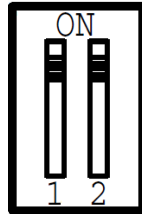
### Initialization / Reset Operation

Set the slide switch to configuration 4 (**SW3A – OFF** and **SW3B – OFF**) when using the board for the 1<sup>st</sup> time or to reset the saved settings on the EEPROM. LED **D1** is expected to blink during power up which indicates a reset operation.



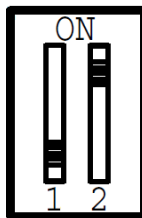
### CV Adjustment

Set the slide switch to configuration 1 (**SW3A – ON** and **SW3B – ON**). This setting will only update the CDC register. The LED **D1** should be BLUE-GREEN in color during this state. The CDC value can be adjusted by using the push buttons and will be automatically saved to EEPROM. The increment and decrement values are shown on Table 2 and Table 3.



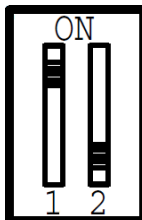
### CV Adjustment

Set the slide switch to configuration 2 (**SW3A – OFF** and **SW3B – ON**). This setting will only update the CV register. The LED **D1** should be RED in color during this state. The CV value can be adjusted by using the push buttons and will be automatically saved to EEPROM. The increment and decrement values are shown on Table 2 and Table 3.



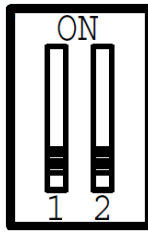
### CC Adjustment

Set the slide switch to configuration 3 (**SW3A – ON** and **SW3B – OFF**). This setting will only update the CC register. The LED **D1** should be GREEN in color during this state. The CC value can be adjusted by using the push buttons and will be automatically saved to EEPROM. The increment and decrement values are shown on Table 2 and Table 3.



### VKP Adjustment

Set the slide switch to configuration 4 (**SW3A – OFF** and **SW3B – OFF**). This setting will only update the CC register. The LED **D1** should be BLUE in color during this state. The CC value can be adjusted by using the push buttons and will be automatically saved to EEPROM. The increment and decrement values are shown on Table 2 and Table 3.



## Operation

### Start-up Operation

When power cycle is done, the board initially checks the setting of the slide switch. If SW3A and SW3B are both **OFF**, then the previously saved EEPROM settings will be erased and default configuration is stored on the EEPROM and sent to the InnoSwitch4-Pro using I<sup>2</sup>C.

Register	EEPROM Default Configuration
<b>CV</b>	5V
<b>CC</b>	192 LSB
<b>VKP</b>	24V
<b>CDC</b>	300 mV

### Normal Operation

When the toggle board is connected to an InnoSwitch4-Pro power stage and input supply is turned ON, the sequence of operation is as follows:

1. The power supply turns ON normally with 5V as usual but the bus switch remains OFF.
2. The uVCC (**J2 Pin-5**) provides power to the toggle board.
3. Microcontroller on toggle board downloads the set point configurations from its memory and uploads it to InnoSwitch4-Pro
4. InnoSwitch4-Pro adjusts the output voltage and current limit accordingly.
5. Microcontroller uses telemetry to confirm InnoSwitch4-Pro is ready with the desired voltage.
6. Microcontroller asks InnoSwitch4-Pro to turn ON the bus switch immediately
  - Bus switch will be ON after 1 sec for voltage lesser than 5V
7. Correct output voltage then appears at the output.

Each time CDC, voltage, current, and/or VKP is adjusted, that information is stored in the EEPROM and downloaded automatically when power is cycled. Once the EEPROM data has been updated, at every power cycle, the button timeout of 5min will automatically start counting and buttons will be disabled thereafter. This provides an opportunity to make any setting changes.



Revision	Notes	Date
A	Initial release.	01/20/23

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