

Summary

Prannng is a 25-bit maximal length polynomial ring pseudorandom number generator. Its output bit randomly changes state approximately every 10µs and the pattern will not repeat for over 5½ hours.

Prannng is firmware for the PIC10F200 microcontroller and is available as a firmware download from www.hexwax.com. Individual devices are programmed in-circuit using the TEAclipper programming clip.

Applications

- Pseudo-random number generator with SPI interface
- Audio noise source up to 50kHz

Features

- Serial random data output
- Optional SPI slave select input
- Invertible sleep control for power saving
- Ultra low cost, low component count
- Based on the PIC10F200 processor
- Available in SOT-23 and DIL packages
- SOT-23 package smaller than 3mm x 2mm
- Industrial and extended temperature ranges
- 2.0V to 5.5V supply
- nanoWatt power during sleep

Functional Diagram

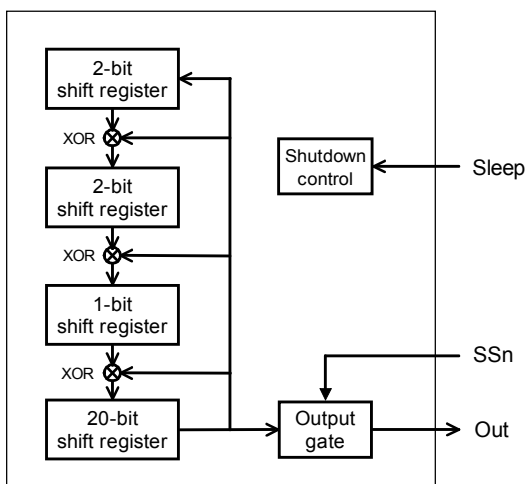
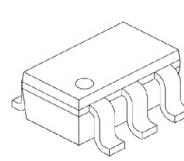
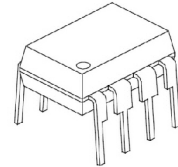


Figure 1 - Functional diagram

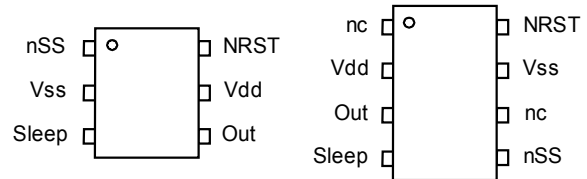
Mechanical Specifications



SOT-23



DIL



Name	Description
SSn	Slave select (chip select), active low TEAclipper programming pin 2
Sleep	Shutdown control TEAclipper programming pin 3
NRST	Reset input, active low TEAclipper programming pin 4
Out	SPI data master in / slave out Noise audio out
Vdd	2.0V – 5.5V supply
Vss	Power supply ground

Electrical Specifications

Voltage on Vdd (Normal use)	2.0 – 5.5 VDC
Voltage on Vdd during programming	4.5 – 5.5 VDC
Typical supply current, active	175µA Vdd = 2V 630µA Vdd = 5V
Maximum supply current, active	275µA Vdd = 2V 1100µA Vdd = 5V
Typical supply current, sleep	100nA Vdd = 2V 350nA Vdd = 5V
Maximum supply current, sleep	1200nA Vdd = 2V 2400nA Vdd = 5V
Operating Temperature, Industrial	–40°C to 85°C
Operating Temperature, Extended	–40°C to 125°C*

*Higher maximum current figures may apply.

Options

The *Sleep* and *SSn* inputs are optional. This allows the component count to be minimized and output rate maximized. The options are set at the time the TEAclipper programming clip is charged with Prannng licenses, according to table 3. Refer to the Firmware Delivery section for details.

Table 3. Prannng options

Option Code	Sleep	SSn
00	Disabled	Disabled
01	Enabled	Enabled
02		Disabled
03	Sleeps when high	Enabled
04	Enabled	Disabled
05	Sleeps when low	Enabled

Operational Description

The polynomial ring repeatedly calculates a random value for the Out pin at the Output Rate t_o as shown in Table 4.

Table 4. Output state change rate

Options enabled	Output Rate t_o	Noise output Nyquist frequency
None	10 μ s	50 kHz
Sleep	12 μ s	41.6 kHz
SSn	12 μ s	41.6 kHz
Sleep & SSn	14 μ s	35.7 kHz

All values $\pm 2\%$ (industrial), $\pm 5\%$ (extended)

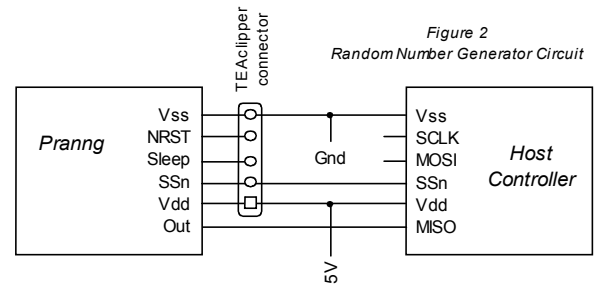
This output may be used directly as a noise output. In addition, it may be used as the MISO (master in, slave out) line of an SPI interface. In this case, the SCLK and MOSI lines do not need to be connected. The SPI clock rate must not exceed t_o .

If the *SSn* option is enabled, the output will only be enabled then *SSn* is low. When *SSn* goes high, *Out* will switch to a high impedance state within a time t_o .

If the *Sleep* option is enabled, the circuit will enter a low power sleep state when *Sleep* is high. In order to minimize unintended wakeup, a 22K pull-up on *SSn* is recommended, even if the *SSn* option is not enabled.

The *NRST* input is an active low reset. During normal operation and programming it should be connected to Vdd via a 22K pull-up. As with all microcontroller circuits, a 100nF decoupling capacitor is recommended across, and as close as possible to, the *Vss* and *Vdd* pins. These components are not shown in the example circuits.

SPI Random Number Generator Circuit



The SPI interface is rather curious in that it requires no clock synchronization. This is because it is unimportant which bit output by the Prannng is read by the master, so long as the same bit is not read twice for consecutive bits. This is the reason why the SPI clock rate must not exceed t_o , even though the pin is not connected.

Noise Source Circuits

The noise output from Prannng is known as white noise because it has an equal power output in all bandwidths up to 50 kHz. Because the output is a square wave, harmonics will exist above the Nyquist frequency and a low pass RC filter may be used to remove these if desired. An example 40kHz filter is shown in figure 2.

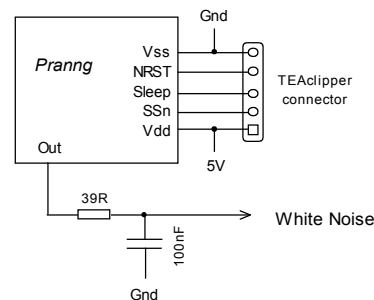


Figure 3
White noise generator circuit

For audio testing purposes, pink noise is preferred because it contains equal power output per octave. Figure 4 shows a typical 3db/octave filter circuit for converting from white noise to pink noise within the audio spectrum.

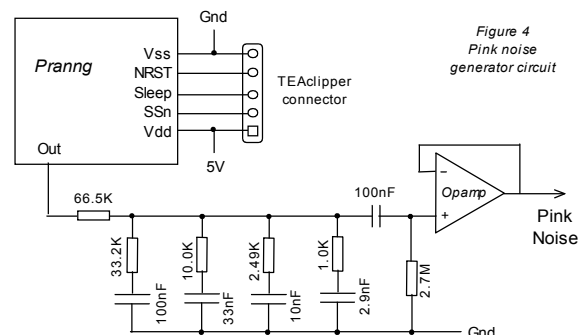


Figure 4
Pink noise generator circuit

Firmware Delivery

The Prnng firmware is available as an encrypted firmware download from www.hexwax.com. To download it you will need a TEAclipper/PIC HV and a TEAclipper/USB adapter.

To load the firmware onto the TEAclipper, start the HexWax Explorer firmware and log in. Then download the Prnng firmware pack from the hexwax.com products section. When download completes, a Prnng folder will appear in the Local Files section of HexWax Explorer. In this folder is the *Prnng.wax* file that contains the firmware.

You will need Prnng license credits in order to decrypt the *Prnng.wax* file. Contact hexwax.com for details of payment options and how to obtain free samples.

Once you have license credits, select the *Prnng.wax* file and insert a TEAclipper/PIC HV into the TEAclipper/USB adapter. Press the **Charge Now...** button. Referring to figure 5, select how many licenses you wish to load onto the TEAclipper. Additionally, select the desired Option Code as specified in table 3. Finally press OK to obtain a decryption key and to charge the TEAclipper with the decrypted firmware.

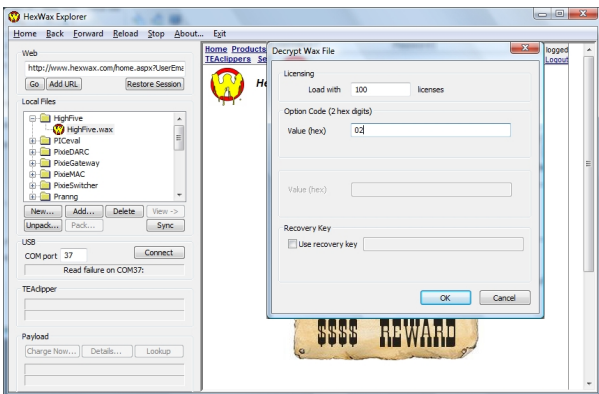


Figure 5: Decrypting the *Prnng.wax* file

Programming Prnng

Prnng may be programmed in-circuit provided the programming signals are protected against contention. In particular, note that the *NRST* line is subject to a voltage of 13V during programming. Example circuits are shown in figures 2-4.

Prnng is programmed into the microcontroller simply by inserting the TEAclipper into its connector. The circuit must be powered and the TEAclipper must be held in place until the LEDs stop flashing and the green LED glows steadily.

Since the programming time is very fast, no programming socket is required for the TEAclipper.

It may be leaned against five plate-through holes as depicted in figure 6.

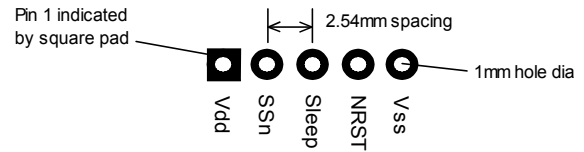


Figure 6. Recommended plate-through connector design

The TEAclipper requires a minimum supply to the Prnng of 4.5V during programming. If the rest of the circuit cannot tolerate a *Vdd* of 5V during programming, then a supply of 5V may be temporarily applied in an isolated fashion as shown in figure 7. (The host *Vdd* should be powered as normal during programming.)

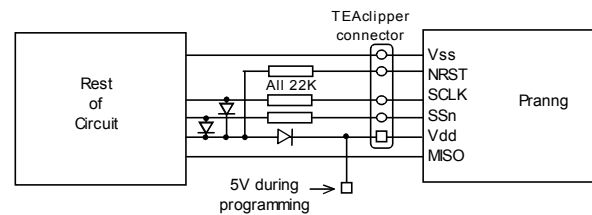


Figure 7. Recommended connection to permit in-circuit programming when the rest of the circuit cannot tolerate *Vdd* of 5V. Resistors and diodes on *SSn* and *SCLK* are only required if these pins connect to the rest of the circuit.

Evaluation Guide

The TEAclipper Evaluation Board contains a PIC10F202 microcontroller originally intended for TEAleaf evaluation. PIC10F202 devices are compatible except for the location of the oscillator calibration bit. So long as you don't mind de-calibrating the oscillator, it may also be used for evaluating Prnng. (See Table 5 for a labeling key.) There is also a ZIF socket to allow you to implement SPI master devices on a variety of processors.

Contact Information



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