Chiplytics

Chiplytics PSA

User Manual

Version 4

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Chiplytics PSA Overview

Power Spectrum Analysis (PSA) is an electrical testing technique that non-invasively stimulates a microelectronics component to extract its unique power signature. Signatures are used to compare components against each other to detect subtle differences for evaluating authenticity and integrity. Data acquisition is performed within seconds with minimal setup, enabling high coverage and throughput.

Advantages

- ➔ Non-invasive, rapid, data-driven counterfeit detection
- ➔ Identifies subtle anomalies that traditionally go undetected
- ➔ Lower cost, more repeatable, and smaller form factor compared to traditional benchtop lab equipment
- ➔ Accompanying software enhances automation and scalability of data acquisition

Use cases

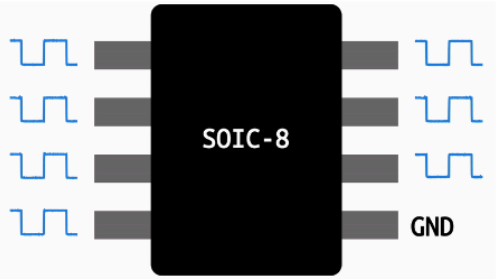
- ➔ Collect power signatures to evaluate homogeneity among a batch of components
- ➔ Compare signatures against a golden sample or run more extensive testing (e.g. destructive) on a subset to verify authenticity of entire batch
- ➔ Capture power signature profiles of aged reference components to predict the health and lifetime remaining of other samples
- ➔ Bin components based on similarities (e.g. performance, grade, usage)
- ➔ Quantify differences between parts before and after failure analysis, radiation hardening, or reverse engineering testing

PSA Detection Capabilities

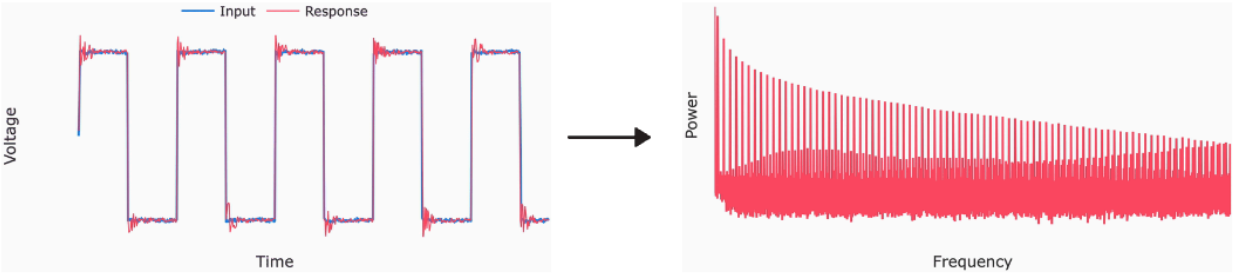
- ➔ Manufacturer and date code
- ➔ Performance including speed and temperature grade
- ➔ Electrical specifications such as memory size
- ➔ Usage including parts that have been recycled
- ➔ Aging including exposure to environmental effects (e.g. radiation)

How it works

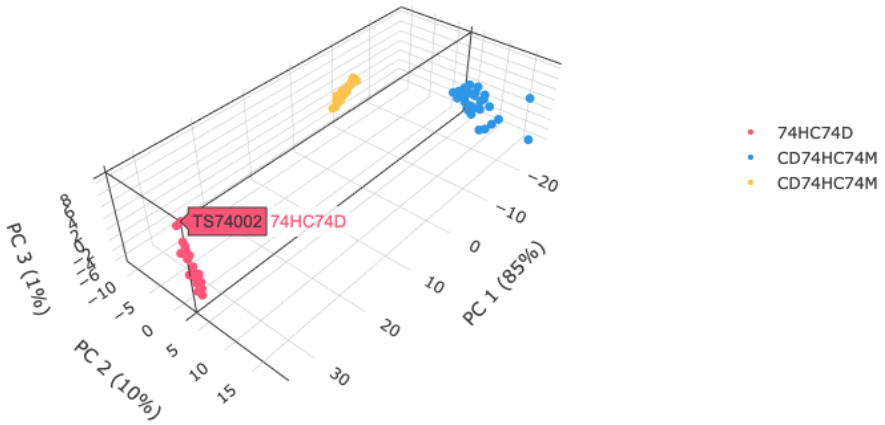
1. Low voltage stimulus captures a unique power response



2. Response converted into a frequency-domain signature



3. Signatures compared using principal component analysis to detect anomalies

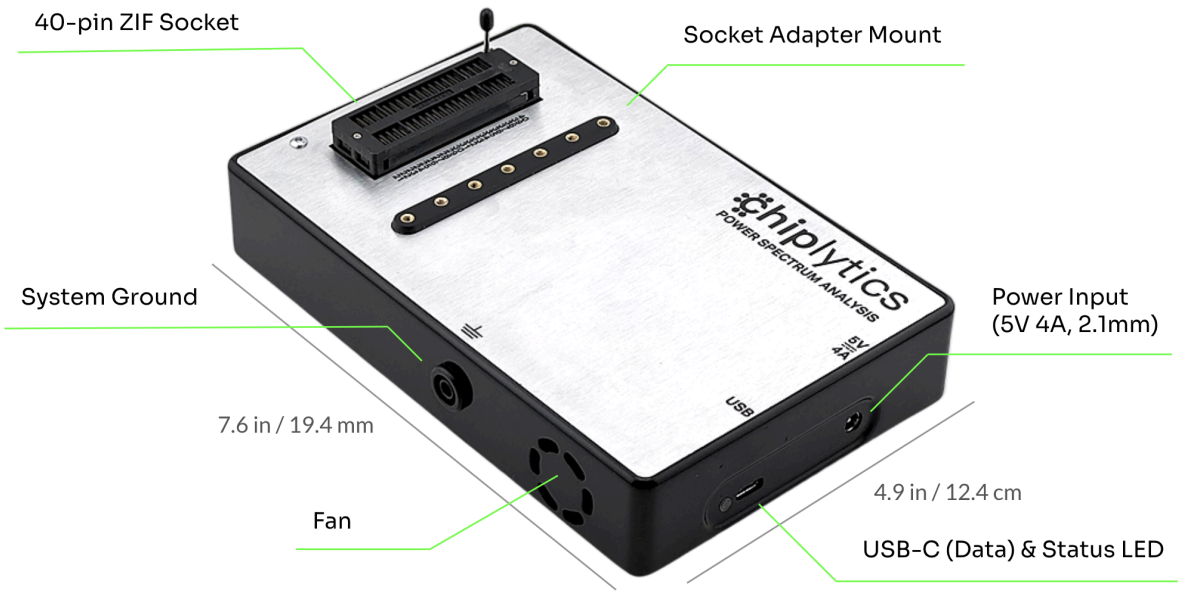


Chiplytics PSA System

Specifications

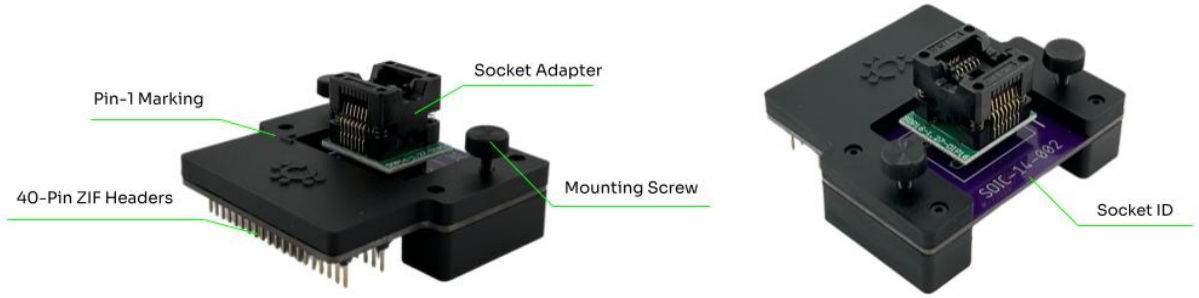
Oscilloscope	1 MΩ || 24pF, ±25 V, differential, 14-bit, 125 MS/s, 30+ MHz Bandwidth
Arbitrary Waveform Generator	±5 V, 14-bit, 125 MS/s, 12 MHz+ bandwidth, 30mA
Power Supplies	0.5 V to 5 V and -0.5 V to -5 V, 800mA
Socket Interface	40-pin Zero Insertion Force (ZIF), 0.1” spacing, 0.3”-0.6” width
Pin Selection	40 pins individually routable to signal or ground channels via reed relays

Diagram



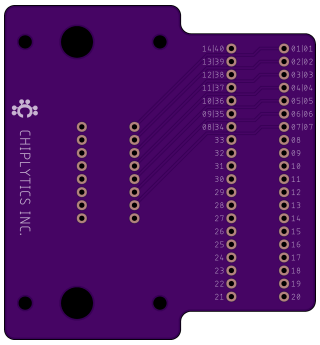
Chiplytyics Quickturn Sockets

Microelectronics components interface with the Chiplytics PSA system's 40-pin Zero Insertion Force (ZIF) socket using a Chiplytics Quickturn Socket. To insert the socket into the PSA system, first make sure the PSA ZIF socket lever is in the vertical (open) position. Then align the ZIF header pins, lower the socket into position, tighten the mounting screws, and set the ZIF lever to the horizontal (closed) position to latch onto the socket header pins.



Socket ID Format: **PACKAGE -PINS-REVISION** (*Example: SOIC-14-002)*

The mapping between each Device Under Test (DUT) and PSA System pins is printed on the bottom of the Quickturn Socket as: **DUT PIN** | **SYSTEM PIN**



SOIC-14 Socket PCB with mapping between DUT and PSA System pins

While any socket adapter may be used with the standard 40-pin ZIF interface, Chiplytics Quickturn Sockets are recommended for enhanced repeatability, compatibility, and ESD safety.

Warnings

1. Incorrect use of this device may lead to improper voltages being applied to the DUT. Reference any relevant datasheets for the DUT to determine safe measurement conditions.
2. The complex impedance of a DUT may affect the applied voltage. Effects like ringing can lead to voltages greater than the set amplitude appearing on the pins of a device. Always ensure that the applied voltage remains within the specified operating conditions or damage may occur.

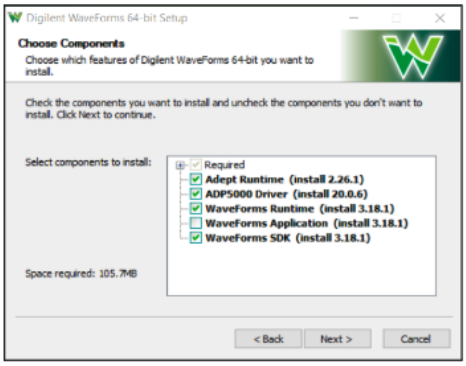
Software Installation

Download the Chiplytics PSA Desktop Application for Windows or Mac: https://chiplytics.io/download

Windows

Operating System: Windows 10 or later (64-bit)

1. Download the compressed .zip file and extract all contents
2. Launch **ChiplyticsSetup.exe** to install the latest version of the Chiplytics application
3. Download the latest version of Digilent Waveforms software (linked under Help menu)
4. Install all Digilent components (Waveforms Application optional)



Windows Digilent Installation

Mac

Operating System: macOS 10.14 (Mojave) or later

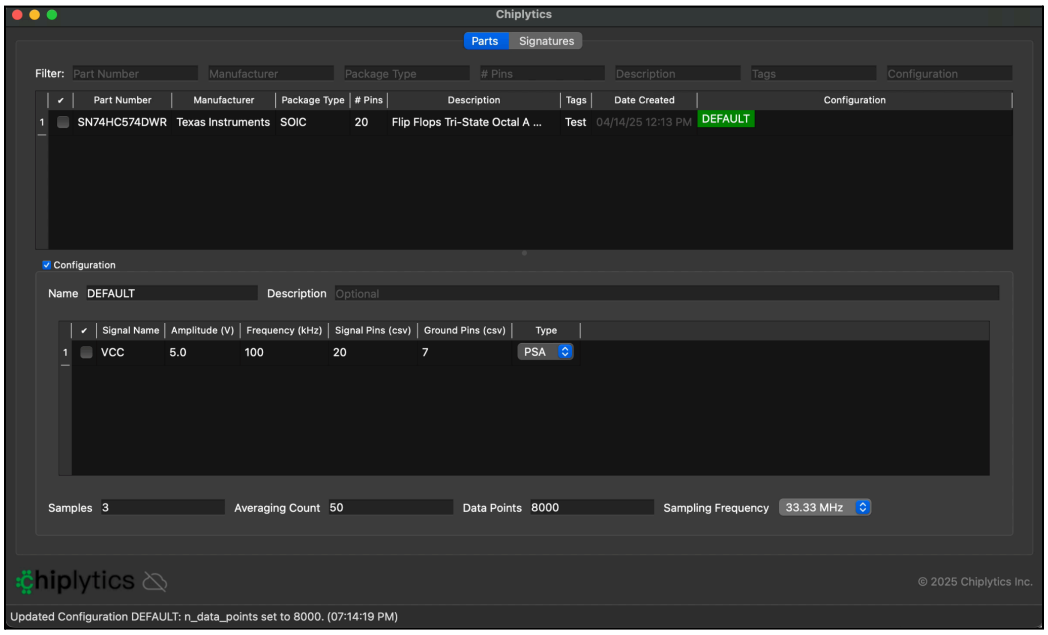
1. Download the compressed .zip file and extract all contents to a new folder
2. Run the **ChiplytivsV4_x.pkg** installer, which should install **Chiplytics** into the Applications folder and **dwf.framework** into the Library/Frameworks folder

Sign-in

To connect to Chiplytics cloud storage, sign-in using an email address and temporary password provided by the Chiplytics Team. Create a new password by clicking Reset Password, which sends an email with password reset instructions. To run the application offline, click “Continue Offline”. Offline data is stored in the operating system’s application data folder.

Parts

To add a part to your library, navigate to **File** > **New** > **Part** in the menubar and enter the part number and other optional metadata including Manufacturer, Package Type, and Tags for part lookup. Then create a **Test Configuration** to specify the test parameters for capturing PSA signatures. Each **Signal** of the Test Configuration is a square wave stimulus with user-defined amplitude, frequency, and socket signal and ground pins. A Fast-Fourier Transform (FFT) is applied to the device’s unique voltage response and averaged a specified number of times to yield a device **Signature** associated with each Signal. The system’s sampling rate and waveform datapoints may also be adjusted, although default settings are recommended.



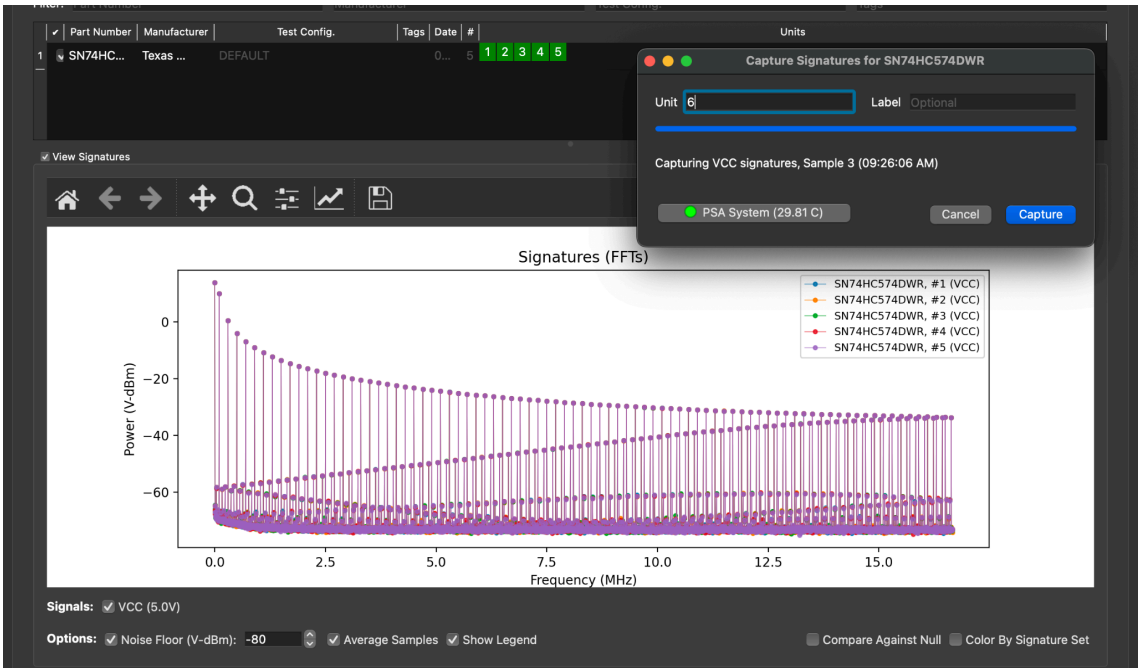
Example Test Configuration setup

Signature Sets

Device signatures are stored under a **Signature Set**, which contains signatures collected across multiple Units (or Samples) that are expected to be the same – for example, the same part number from the same manufacturer, vendor, and date code, collected on the same Chiplytics PSA System. Create a new Signature Set under **File > New > Signature Set** or by right-clicking a selected Part and choosing New Signature Set. Specify the Test Configuration and any metadata including vendor and date code.

Capturing Signatures

Once a Signature Set is created, the Capture Signatures dialog opens by default or by right-clicking a selected Signature Set and choosing Capture Signatures. The Chiplytics PSA System should connect by default; otherwise, ensure that the system is plugged in and click the PSA System button to connect (see Troubleshooting if necessary). Ensure that the DUT is inserted into the PSA System, specify the Unit Number and optionally a Label, then click Capture to run through the Test Configuration and capture Signatures.

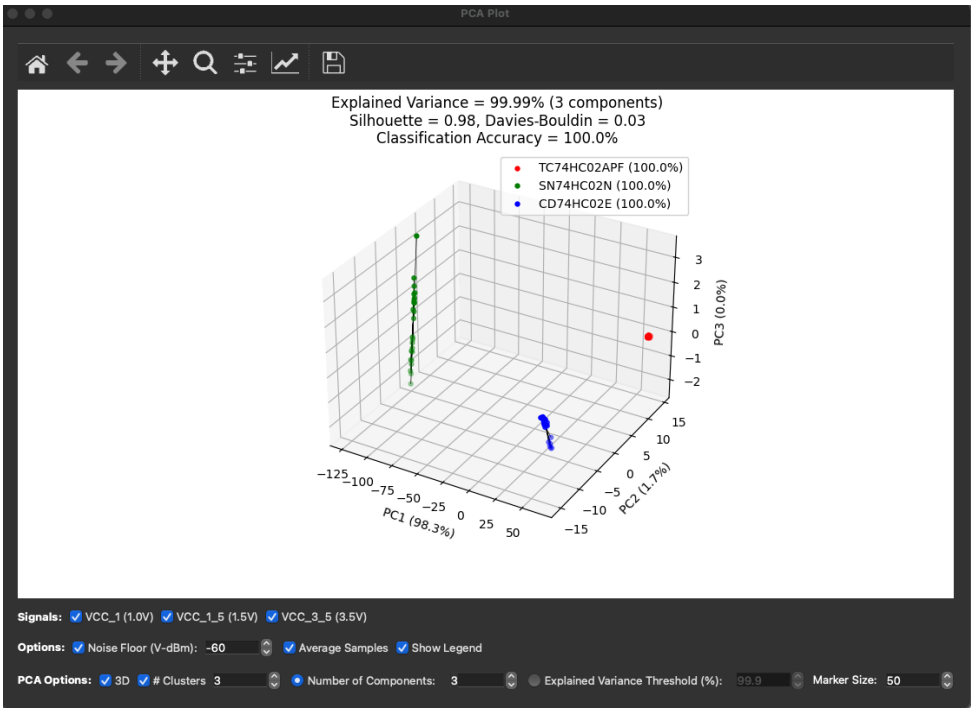


Example Signature Capture

For the first Unit, a set of Null Signatures are collected with all signal and ground pins disabled to capture Signatures of the test fixture itself. Once the capture is complete, the Unit's Signature is displayed and Number is auto-incremented for the next Unit. Delete or disable a Unit through right-clicking the corresponding label inside the Units column of the Signatures tab. Plot more Signatures by multi-selecting Units then double-click, right-click, or navigate to **Plot > Signatures** in the menubar.

Principal Component Analysis

Signatures are compared against each other through **Principal Component Analysis (PCA)**, which transforms the signatures into principal components ordered based on the degree of variance held in each component (where PC1 holds the most variance), creating a visual representation of the differences between Signatures. The **Explained Variance Ratio** (EVR) quantifies how much variance is held in each principal component, labeled as a percentage along each axis of the PCA plot. To generate a PCA plot, select the Units to be used in the analysis then navigate to **Plot > PCA** in the menubar.



Example PCA Plot with Clustering Metrics

Signatures from all Signals are concatenated to form a single overall **Composite Signature** for each Unit. By default, the Composite Signatures of all Samples (or Replicates) are averaged together. Alternatively, Signals can be omitted from the analysis or Samples can be run through PCA individually through toggling the corresponding checkboxes. **K-Means Clustering** can be enabled on the PCA data, where classification metrics are displayed when the number of clusters equals the number of signature sets, which are taken to be the truth data.

Exporting Data

To export signatures for processing outside of the Chiplytics app, switch to the Signatures tab, select the Signature Sets you wish to export, then navigate to **File > Export Signature Sets** in the menubar. The data can either be exported as a formatted CSV file for readability or raw JSON file for nested storage of metadata. A private Chiplytics Python SDK is also available upon request to interact with the data outside of the app without needing to export data.

Troubleshooting

System Connection

1. Confirm that only a single Chiplytics application is open
2. Confirm that the provided USB-C cable (with data lines and high current capacity) and power cable (5V 4A) are used
3. Power cycle the Chiplytics PSA system by disconnecting both the USB and power cables then reconnecting.
4. Plug the USB cable into a different USB port
5. Restart the Chiplytics application
6. Restart the computer
7. If running on Windows, make sure the latest version of Digilent Waveforms is installed

Socket Connection

Please confirm the following if you are noticing issues with device Signatures:

1. Socket header pins are aligned with the 40-pin ZIF socket
2. ZIF socket lever is closed (horizontal) to latch onto Socket header pins
3. DUT is fully inserted into the socket adapter and making sufficient contact with the leads
4. Pins specified under Signal settings are for the Chiplytics PSA System 40-pin ZIF socket (1-40), which may not be 1:1 with DUT pins
5. Correct mapping is applied between the DUT and ZIF socket pins

Customer Support

Please email support@chiplytics.io regarding any questions, issues, or feedback related to any Chiplytics products.