
Keysight Smartcard Power Tracer

DS1220A Smartcard Power Tracer

Notices

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CAUTION

A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

WARNING

A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or with specific warnings elsewhere in this manual violates safety standards of design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements. Before operation, you should review the instrument and manual for safety markings and instructions. You must follow these to ensure safe operation and to maintain the instrument in safe condition.

General

WARNING

This product has been manufactured and tested according to international safety standards. The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

WARNING

Use only the Keysight supplied power cord or cords with the same or better electrical rating.

Using other power cords may present a fire hazard or cause serious to deadly injury.

WARNING

Use only the Keysight supplied power supply.

Using other power supplies may present a fire hazard or cause serious to deadly injury.

Cleaning the instrument

WARNING

To prevent electrical shock, disconnect the instrument from mains before cleaning.

Use a dry cloth slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

For information regarding [Connections to External Circuits](#) refer to page 13.

For information regarding device specific [Safety Instructions](#) refer to page 33.

Before Applying Power

Verify that all safety precautions are taken. The power cable inlet of the instrument serves as a device to disconnect from the mains in case of hazard. The instrument must be positioned so that the operator can easily access the power cable inlet. When the instrument is rack mounted the rack must be provided with an easily accessible mains switch.

Do not Operate in Explosive Atmosphere








Do not operate the instrument in the presence of flammable gases or fumes.

Do not Remove the Instrument Cover

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified personnel.

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

Instrument Markings

Instrument Marking	Description
	The instruction manual symbol. The product is marked with this warning symbol when it is necessary for the user to refer to the instructions in the manual.
	Direct Current.
	Alternate Current.
	The CE mark is a registered trademark of the European Community.
	The UK mark is a registered trademark of the United Kingdom.
	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
	The KC mark is the Korean certification mark. This equipment is Class A suitable for professional use and is for use in electromagnetic environments outside of the home.



Product tested and certified by CSA Group to meet safety and performance standards for both Canada and US



Electro Static Discharge. Attach ESD protective wrist strap to avoid damage by direct contact with the equipment.



China Restricted Substance Product Label. The EPUP (environmental protection use period) number in the center indicates the time period during which no hazardous or toxic substances or elements are expected to leak or deteriorate during normal use and generally reflects the expected useful life of the product.

ccr.keysight@keysight.com

This is the Keysight email address required by EU directives applicable to our product.



The crossed out wheeled bin symbol indicates that separate collection for waste electric and electronic equipment (WEEE) is required, as obligated by the EU DIRECTIVE and other National legislation.

Please refer to [keysight.com/go/takeback](https://www.keysight.com/go/takeback) to understand your Trade in options with Keysight in addition to product takeback instructions.

Declaration of Conformity

Declarations of Conformity for this product and for the Keysight products may be downloaded from the Web. Go to <https://www.keysight.com/go/conformity>. You can then search by product number to find the latest Declaration of Conformity.

Specification

Environmental Specifications

Parameter	Description	Comment
Ambient operating temperature	10 – 30 °C	
Ambient non-operating temperature	-10 – 50 °C	
Humidity	< 90 %	Non-condensing
Operating altitude	Up to 2000 m	
Overvoltage category	II	
Pollution degree	2	For indoor use only

Electrical Specifications

For detailed power input ratings of this product the rating label placed on the product can be also referred.

AC Adaptors

Parameter	Description
Line Voltage	100 – 240 V~
Line Frequency	50 – 60 Hz
Input Current	1.0 A max.
Line Voltage Fluctuations	± 10 %
Output Voltage	15 V _{DC}
Output power	36 W max.

Where to Find the Latest Information

Documentation is updated periodically. For the latest information about these products, including instrument software upgrades, application information, and product information, browse to one of the following URLs, according to the name of your product:

<https://www.keysight.com/us/en/product/DS1220A/smartcard-power-tracer.html>

To receive the latest updates by email, subscribe to Keysight Email Updates at the following URL:

<https://support.keysight.com>

Information on preventing instrument damage can be found at:

<https://www.keysight.com/find/PreventingInstrumentDamage>

Is your product software up-to-date?

Periodically, Keysight releases software updates to fix known defects and incorporate product enhancements. To search for software updates for your product, go to the Keysight Technical Support website at:

<https://www.keysight.com/find/techsupport>

Product and Solution Cybersecurity

Keysight complies with multinational regulations for the cybersecurity of its own products and is committed to providing information to assist you in protecting your products and solutions from external cyber threats. For more information, see:

<https://www.keysight.com/us/en/about/quality-and-security/security/product-and-solution-cyber-security.html>

Keysight also recommends that you secure your IT environments using appropriate third-party tools. For instruments that run the Microsoft Windows operating system, Keysight concurs with Microsoft's recommendations for ensuring that the instrument is protected:

- Get the latest critical Windows updates
- For network-connected instruments, use an Internet firewall (in Keysight instruments, Windows Firewalls enabled by default)
- For network-connected instruments, use up-to-date antivirus and anti-spyware software

Responsible Disclosure Program

Keysight recommends that security researchers share the details of any suspected vulnerabilities across any asset owned, controlled, or operated by Keysight (or that would reasonably impact the security of Keysight and our users) using this form:

<https://www.keysight.com/us/en/contact/responsible-disclosure-program.html>

Report a Product Cybersecurity Issue

If you discover a cybersecurity issue that you suspect may involve Keysight's proprietary software, or third-party software supplied by Keysight as part of a product, or that may affect the operation of Keysight products, we encourage you to report it to us using this form:

<https://www.keysight.com/us/en/about/quality-and-security/security/product-and-solution-cyber-security.html>

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Manufacturer's Address

Keysight Technologies Netherlands Riscure B.V.

Delftechpark 49

2628 XJ Delft, The Netherlands

What's in the Box?

The box contains the Smartcard Power Tracer and all accessories to connect it to a computer and an oscilloscope.

Quantity	Description	Identifier ¹
1	Smartcard Power Tracer 4	
1	Power Supply Unit 15 V DC — input 100 V to 240 V AC, 50 .. 60 Hz	PSU
	Power cable (included with PSU)	
2	Signal cable: — BNC to BNC, 50 Ω , coaxial	BNC50
1	Proprietary split cable: — PS2 to RS232/Probe-power.	PS2PRB
1	Communication cable: — USB, USB-A to USB-B	USB
1	Low-pass filter: — 50MHz, 50 Ω , BNC male-to-female	LPF50
1	Low-pass filter: — 90MHz, 50 Ω , BNC male-to-female	LPF90
1	Impedance adapter: — 50 Ω , BNC to BNC	IMPA50
1	Smart card for training purpose: — 3DES in software	TC2
1	Smart card for training purpose: — AES in software	TC3
1	Smart card for training purpose: — ECC in software+ DES in hardware	TC8
1	Extension card	
1	This “DS1220A Smartcard Power Tracer User Manual”	

1. Identifiers are used in references in this document.

Connections to External Circuits

All external I/O connections are supplied by non-hazardous voltages supplied by circuits of limited energy.

WARNING

All external inputs connected to ports shall provide reinforced or double insulation against hazardous voltages for protection against electric shock and shall have voltage below 30 Vrms and 42.4 Vpeak or 60 VDC.

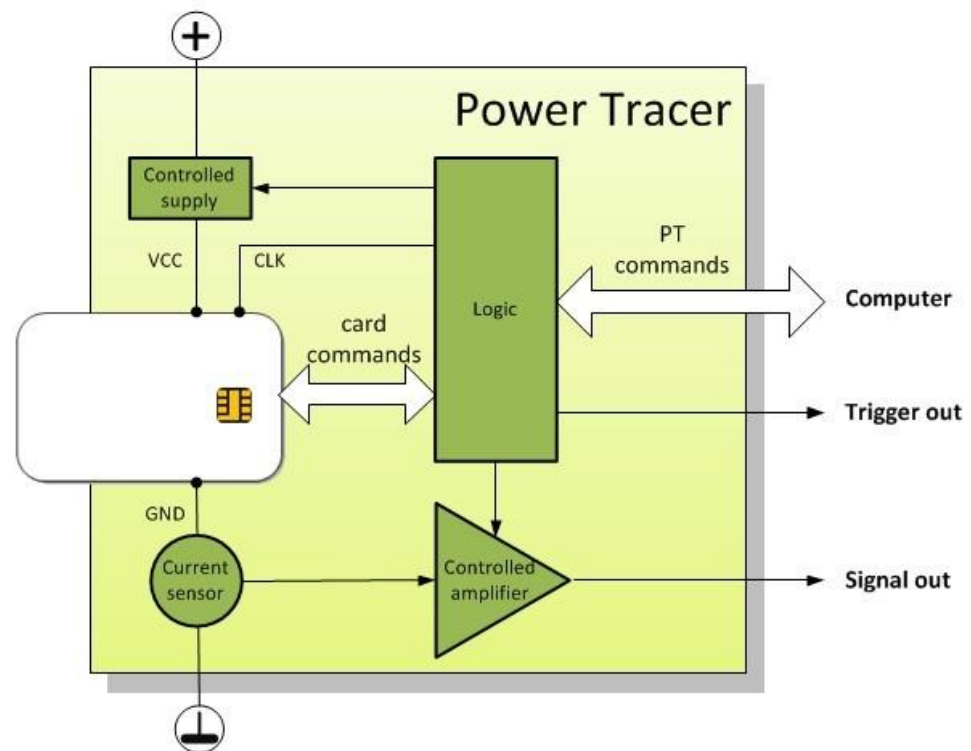
CAUTION

Connecting an instrument to voltages other than rated may introduce excessive voltage and damage the device. Excessive voltage can lead to thermal stress, breakdown of insulating materials, or direct electrical failure, necessitating repairs or replacements. Always refer to product model specifications to avoid such damage.

What It Does

The Smartcard Power Tracer is a plug and play smart card reader with side channel analysis (SCA) capabilities. It can measure the power consumption of the smart card with a high sensitivity.

Figure 1 Functional overview of the Smartcard Power Tracer



The Smartcard Power Tracer produces a trigger out signal when the smart card is going to execute a command. This signal is useful for synchronization of other measurement devices.

The Smartcard Power Tracer enables the tuning of the card's power supply, the card's clock frequency, and the offset and gain of the current amplifier.

The Smartcard Power Tracer is normally used in combination with Inspector. You can also use the Software Development Kit (SDK) to develop custom applications that communicate with the Smartcard Power Tracer.

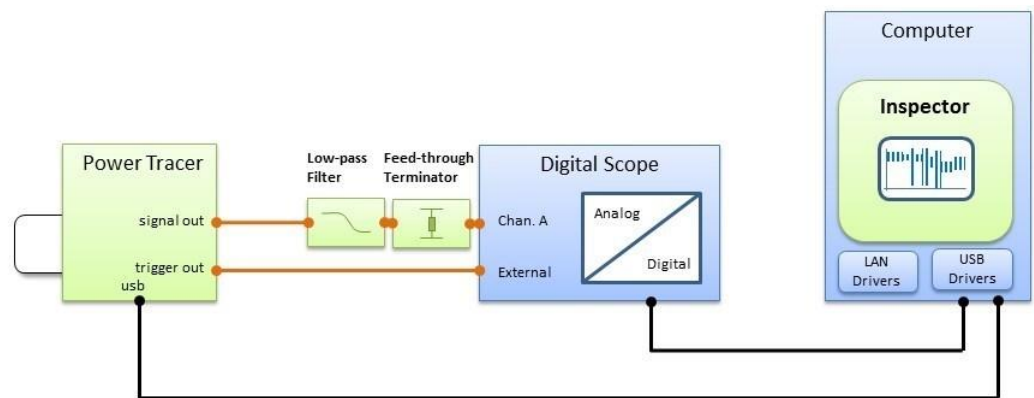
How to Build a Setup

Typical setup with a digital storage scope

In this setup the power consumption of the smart card, when it is executing a cryptographic command, is measured and digitized by the digital oscilloscope.

After a trigger out event, the scope records a configured number of samples into a trace. Inspector retrieves and stores these traces.

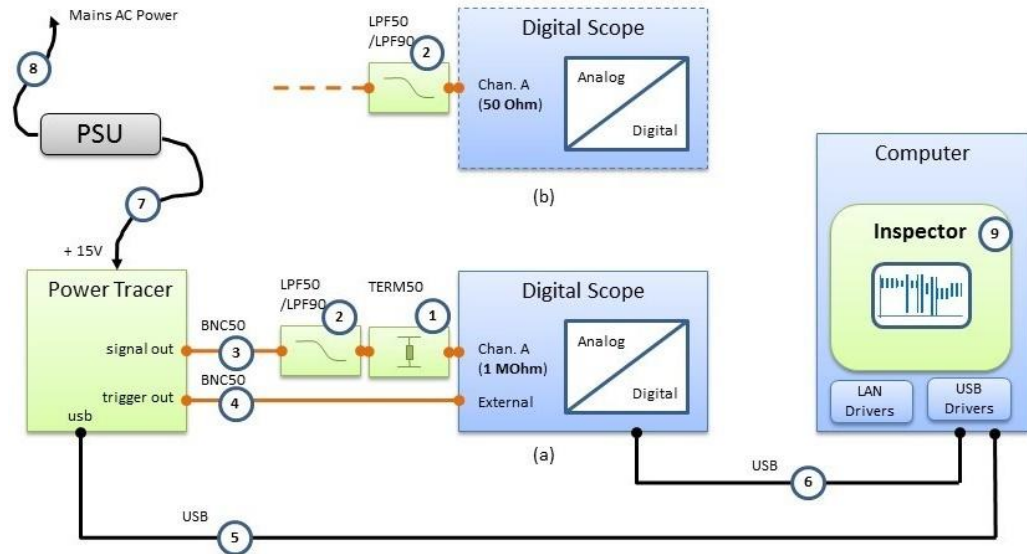
Figure 2 Smartcard Power Tracer setup with a digital storage scope



How to connect a typical setup

Preparation: Install the Inspector application (or the Smartcard Power Tracer SDK) to provide for the Smartcard Power Tracer USB drivers.

Figure 3 Stepwise connecting a setup with the Smartcard Power Tracer



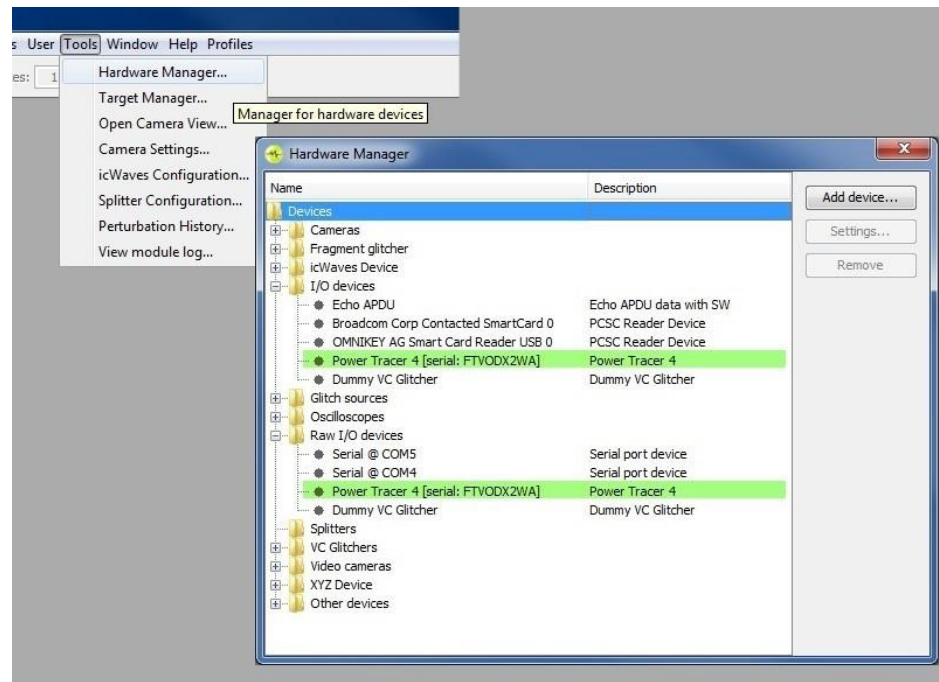
Take the following steps:

1. Connect the adapter IMPA50, if needed, to Channel A of the scope (For guidance, see next section).
2. Choose a low-pass filter LPF50 or LPF90 and connect it to the IMPA50 (For guidance, see next section).
3. Connect signal out of the Smartcard Power Tracer with a BNC50 cable to the LPF.
4. Connect trigger out of the Smartcard Power Tracer with a BNC50 cable to the External trigger channel of the scope.
5. Connect USB of the Smartcard Power Tracer with the USB cable to the computer.
6. Connect the scope with the USB cable to the computer.
7. Insert the power supply plug of the PSU into the +15V port of the Smartcard Power Tracer.
8. Plug the PSU into a mains power wall socket.
 - On the computer, the Smartcard Power Tracer is detected and registered as plug and play device. Drivers will be installed if needed.

9. Inspector will automatically record the Smartcard Power Tracer as I/O device. Verify the presence of the Smartcard Power Tracer in the hardware manager. Select Tools >> Hardware Manager. See branch I/O Devices. See brank Raw I/O Devices.

Figure 4

The Smartcard Power Tracer 4 registered in the Hardware Manager



10. Insert a training card (or your own smart card).



- The Smartcard Power Tracer display message changes from “NO CARD INSERTED” to “CARD NOT POWERED”.

Your setup is now ready for measurement!

NOTE

A smart card can be safely inserted and removed when the Smartcard Power Tracer is powered.

WARNING

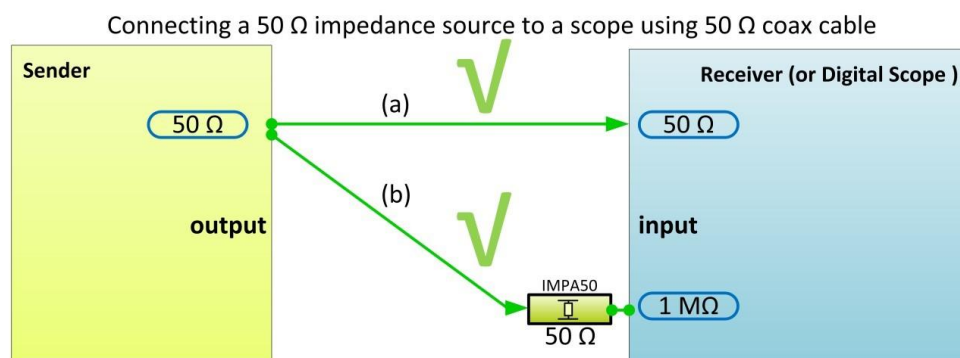
Do not unplug the power or USB cable while the Smartcard Power Tracer is being initialized by Inspector.

When to apply an impedance adapter?

Transfer of analog signals between devices are standardized using 50 Ω coax cables.

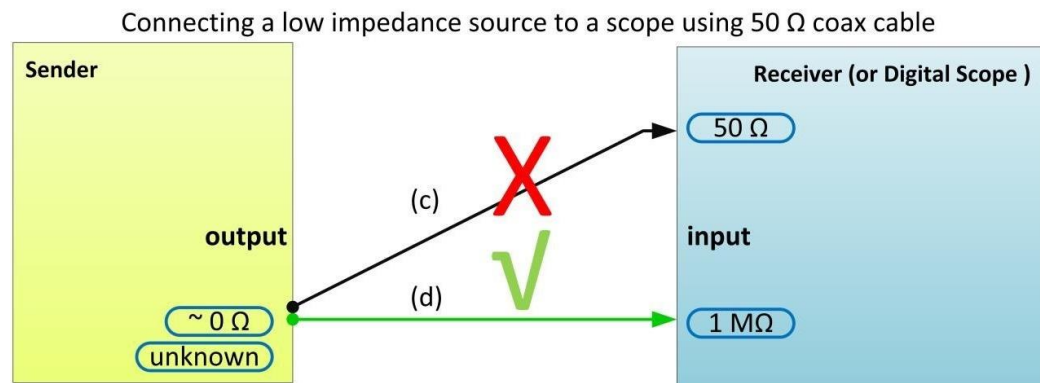
Figure 5

Connecting a 50 Ω source to a scope



For the best quality of transfer, output and input must have a matching 50 Ω impedance (Figure 5, a). If the receiver only has a 1 M Ω input (Figure 5, b) and distortions or echoes aren't acceptable, then a 50 Ω impedance adapter must be prefixed to the input connector. Be aware that the received amplitude will now be half of the sent amplitude.

Figure 6 Connecting a low impedance source to a scope



The 1 M Ω input is suitable for the accurate handling of rising/falling edges of digital signals.

Which low-pass filter to choose?

The goal of analog to digital conversion is a reliable representation of the measured analog signal. The quality of this representation is influenced by the sample rate and quantization precision.

The original signal can be reconstructed if the sample rate is at least two times the highest frequency present in the signal (Nyquist/Shannon-theorem).

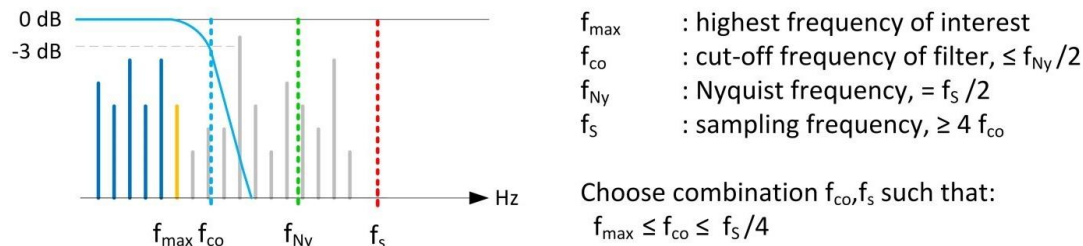
Minimum and recommended sample rate

To speed up data analysis, the sample rate must be kept as low as possible. To be able to lower the sample rate, apply a low-pass filter. The filter removes unwanted high frequencies from the signal.

Physical low-pass filters however do not have an ideal cut-off characteristic. Subsampling artefacts will show up when the signal is sampled at the (theoretical) Nyquist rate. The recommended sample rate therefor is at least four times the LPF cut-off frequency.

Figure 7

Balancing the filter cut-off frequency and the recommended sample rate.



Frequencies of interest are:

- The clock frequency of the central processor unit (CPU), usually defined by an internal clock.
- The clock frequency of crypto core(s), which could be different than those of the CPU.

Table 1

Recommended combinations of low-pass filter and sample rate

Focus of interest	Clock frequency	Low-pass filter cut-off frequency (identifier)	Scope sample rate (recommended minimum).
Patterns in the overall operation, for example a crypto algorithm.	1 MHz – 160 MHz	1.9 MHz (LPF1M9) ^{1,2}	≥ 10 MSa/s
Details of a specific operation, for example a crypto round.	1 MHz – 40 MHz	50 MHz (LPF50M)	≥ 200 MSa/s
	40 MHz – 80 MHz	90 MHz (LPF90M)	≥ 400 MSa/s
	80 MHz – 160 MHz	200 MHz (LPF200M) ²	≥ 800 MSa/s

1. There are cases you may desire to sample at a lower rate than the CPU clock frequency. This has consequences for the LPF. Use an LPF with a cut-off frequency $\leq 1/4$ of the desired sample rate!
2. These filters are not supplied with the Smartcard Power Tracer.

How to Verify Your Setup

To check whether your setup is correct, perform the next checks in order:

1. Is the Smartcard Power Tracer powered?
2. Is the Smartcard Power Tracer recognized by the computer?
3. Is the Smartcard Power Tracer responding to commands?

Please ensure that each procedure is successful, before proceeding to the next one.

If not successful, refer to page 18 for a solution.

1. Is the Smartcard Power Tracer powered?

If the Smartcard Power Tracer is powered, the front display lights up.

After power on, the display shows a message with the Smartcard Power Tracer version and a copyright string.

Figure 8

Initial Smartcard Power Tracer display after power on.



After establishing communication with Inspector (and no card inserted), the displayed message changes to:

“NO CARD INSERTED”.

When a card is inserted, the displayed message changes to:

“CARD NOT POWERED”

When the card is removed, the displayed message changes to:

“CARD NOT INSERTED”

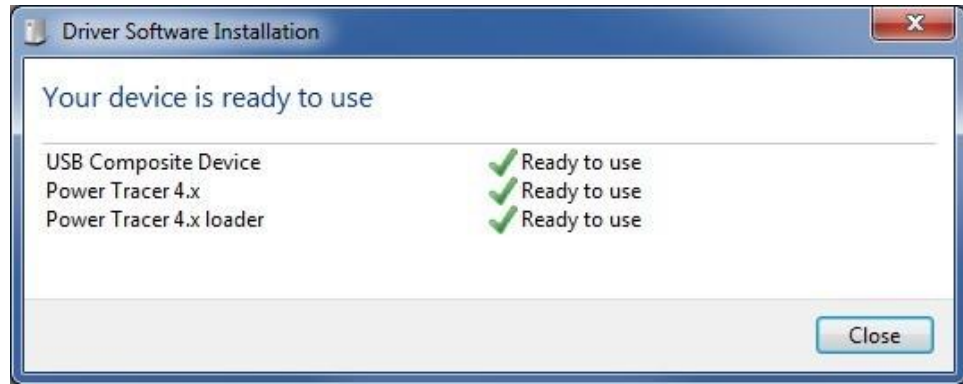
2. Is the Smartcard Power Tracer recognized?

1. To control the Smartcard Power Tracer from a computer, it must be recognized as a USB device. The device driver for the Smartcard Power Tracer is included in the installation of the Inspector application and is available for Windows only.

2. Windows will automatically recognize the Smartcard Power Tracer when it is plugged into a USB port.

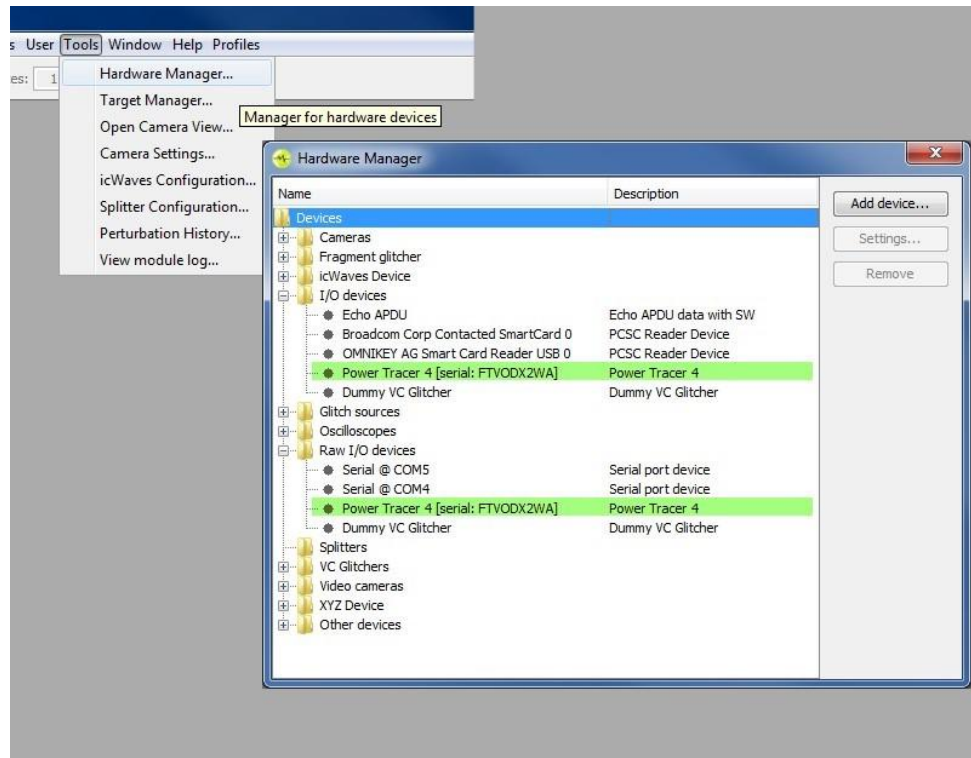
Figure 9

Automatically installing the USB device driver for the Smartcard Power Tracer 4



3. At startup, Inspector searches for available Smartcard Power Tracer devices and lists them in the Hardware manager.

To open the Hardware Manager: select Tools >> Hardware Manager

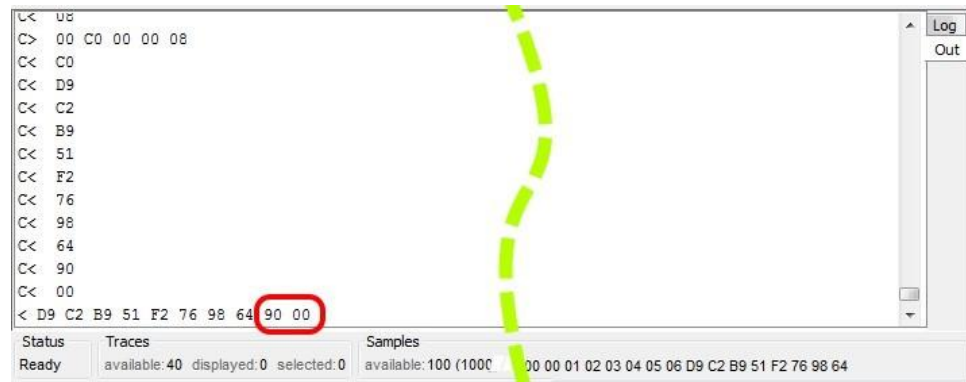


3- Is the Smartcard Power Tracer responding to commands?

Preparation: Insert training smart card TC8 into the Smartcard Power Tracer, with the contact pads down.

1. In Inspector, select Acquisition >> Scope – Protocol.
 - The Scope Acquisition dialog opens.
2. Select tab [General]
 - Enter 10 in ‘Number of measurements’.
 - Mark checkbox ‘Accept measurements with errors’.
 - Unmark checkbox ‘Limit errors’.
3. Select tab [Measurement Setup]:
 - From Oscilloscope list, select Sine Generator.
4. Select tab [Target]:
 - From Protocol list, select Training card 8 (choose id of inserted smart card).
 - From Trigger phase list, select Crypto command.
 - Unmark checkbox ‘Stop protocol after trigger’.
 - In Protocol settings, from Algorithms-list, select DES.
 - In I/O device list, select Smartcard Power Tracer 4.
 - Mark checkbox ‘Use low noise power supply’.
 - Mark checkbox ‘Low level communication logging’.
5. Press button ☒ to accept the values entered and to close the dialog.
6. Inspector starts the acquisition by exchanging data with the Smartcard Power Tracer and with the smart card. The acquisition will complete within a few seconds.
7. A trace window opens and displays the simulated sine wave.
8. Observe the Out panel at the bottom of the screen.

- The bytes exchanged with the smart card are listed as hexadecimal value pairs. Communication is indicated by direction arrows ">" (sent by Inspector) and "<" (received from smart card).
- Scroll down to the last line.
- The card should finish its response with bytes '90 00', indicating a successful completion.



How to Control with Custom Applications

Setup for application development

Figure 10 Using the SDK to communicate with the Smartcard Power Tracer



Smartcard Power Tracer SDK

A software development kit (SDK) is available to build custom applications for the Smartcard Power Tracer. This SDK implements the Smartcard Power Tracer application programmer interface (API) and enables you to exchange data with the Smartcard Power Tracer and the smart card.

The SDK contains:

- Header and library files to be linked with your C/C++ source code.
- Documentation on the API.
- USB drivers for the Smartcard Power Tracer.
- Example python script files on how to use the API and verify the Smartcard Power Tracer connection.

Current Windows version supported by the SDK is Windows 7.

For more information, visit Keysight Support: <http://support.keysight.com>

Help and Troubleshooting

Common problems

NOTE

Order of connecting a USB cable.

First, fully connect the USB cable to the computer at both ends, then power the Smartcard Power Tracer.

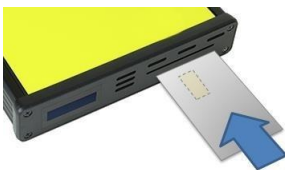
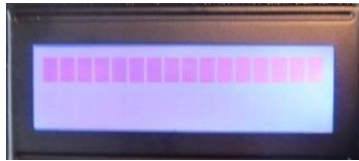
Problem	Cause	Solution
The Smartcard Power Tracer LCD display shows a full screen of white dots.	Occasional glitches have occurred when setting up the USB connection.	Unplug the PSU from the Smartcard Power Tracer. Re-insert the USB connector. Reconnect the PSU to the Smartcard Power Tracer
The Smartcard Power Tracer LCD display shows: “NO CARD INSERTED”.	No smart card present. .	Insert a smart card.
	Smart card inserted wrong.	Insert smart card with contact pads down.
	Smart card is not fully inserted.	Gently push smart card until blocked.
The Smartcard Power Tracer LCD displayed shows: “CARD NOT POWERED”.	This is not a problem but reflects the status when no command is sent to the card. The card will be powered when measurements start from Inspector.	
Inspector - Module Execution Error: “CANNOT RUN MODULE <path>\ScopeAquisition.class”	The acquisition model could not establish communications because the card is inserted upside down.	Re-insert it with contact pads down. 

Figure 11. Correct orientation to insert a smart card

Smartcard Power Tracer is not working. The Smartcard Power Tracer LCD display shows a full progress bar:



The Smartcard Power Tracer is not successfully initialized. This may happen when power or communications to the device was lost during the initialization.

The Smartcard Power Tracer needs to be re-initialized with factory settings.

Please visit:
<http://support.keysight.com>

Interoperability issues

NOTE

Inspector 4.6 only

An update is required for the Smartcard Power Tracer 4 SDK.

Smartcard Power Tracer initialization

Inspector tools and software are continuously improved. On your Windows desktop there can be different versions of Inspector applications open at the same time, but only one is the 'active' application having the focus of user control.

To maintain interoperability, the 'active' Inspector will temporarily initialize the Smartcard Power Tracer when it is selected as I/O device for first use. This initialization state is lost after a power-off or after a re-initialization of the Smartcard Power Tracer. An ongoing initialization is visible by a progress bar on the Smartcard Power Tracer display, and usually takes a few seconds.

WARNING

Please do not unplug the power or USB cable when the Smartcard Power Tracer is being initialized. An aborted initialization will corrupt the Smartcard Power Tracer and make it inoperable.

Still have questions?

Go to the Inspector Help menu and read detailed information about the Smartcard Power Tracer device.

Visit the Keysight Support Portal: <http://support.keysight.com>

Technical Specifications

Operational conditions

- Room temperature 20 - 30 °C, (68 – 86 F).

WARNING

Do not block the ventilation holes of the Smartcard Power Tracer. A blocked air flow may cause malfunction or break down.

NOTE

Maintain a stable and identical environment to reliably repeat tests.

NOTE

Unplugging the PSU from the Smartcard Power Tracer is not required but recommended when not used for an extended time.

Power supply input

- 15 V DC, max 800 mA
- Center-positive plug, inner-Ø 2.5 mm, outer-Ø 5.5 mm.

WARNING

Use of a PSU other than supplied by Keysight is not supported. Power spikes may cause internal damage and loss of accuracy.

Clock generation for smart card

- Software adjustable [1 .. 10 MHz], default 4 MHz.
- Unsharpened square wave (low harmonics), buffered.

Current measurement circuit

- Amplifier, low noise (26 pA / $\sqrt{\text{Hz}}$ @ 1 MHz), high bandwidth (-3 dB @ 1.5 GHz).
- Virtually zero-ohms for high bandwidth.

- Isolated electrically from digital control circuit for low-noise signal.
- Fed by capacitors during measurement for low-noise signal.
- Software configurable gain 100 % .. 200 %.
- Software configurable offset 0 .. -30 mA.
- Software configurable smart card voltage 1.8 .. 6.0 V.

USB connector:

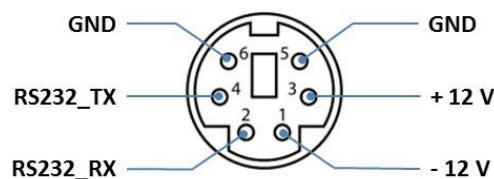
- USB 2.0, type USB-B, connection to PC.

BNC output connectors:

- Trigger out, TTL-level triggering, 1 μ s trigger delay resolution, active rising edge, pulse duration $\sim 10 \mu$ s, trigger generated at completion of request block transfer to smart card.
- Clock out buffered TTL output, square wave oscillator, synchronous to smart card clock.
- Reset out buffered TTL output, the signal from smart card reset pad.
- IO out, buffered TTL output, the signal from smart card IO pad.
- Signal out, impedance 50 Ω , buffered output, the analog signal proportional to smart card power consumption.
- Output range ± 4 V for 1M Ω oscilloscope input impedance.
- Output range ± 2 V for 50 Ω oscilloscope input impedance.

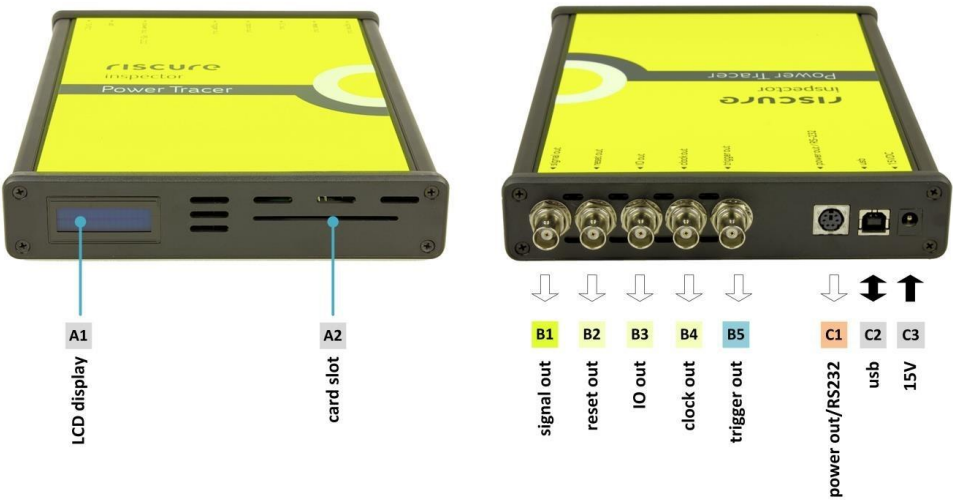
Power/RS232:

- Proprietary use of PS/2 connector to support probe hardware.



Product case

Dimensions L x W x H: 220.00 x 169.50 x 34.63 [mm],
8.661 x 6.673 x 1.363 [inch].



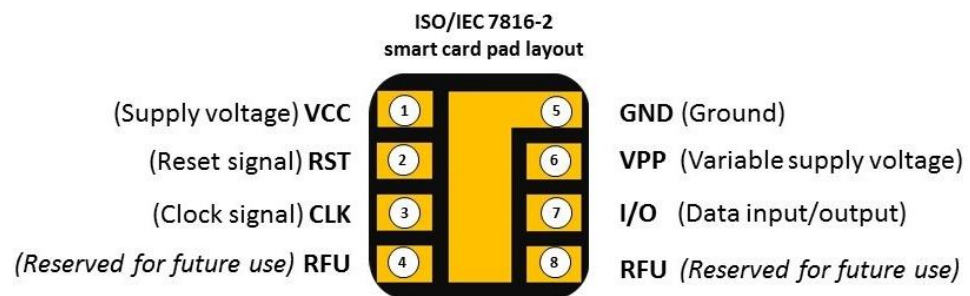
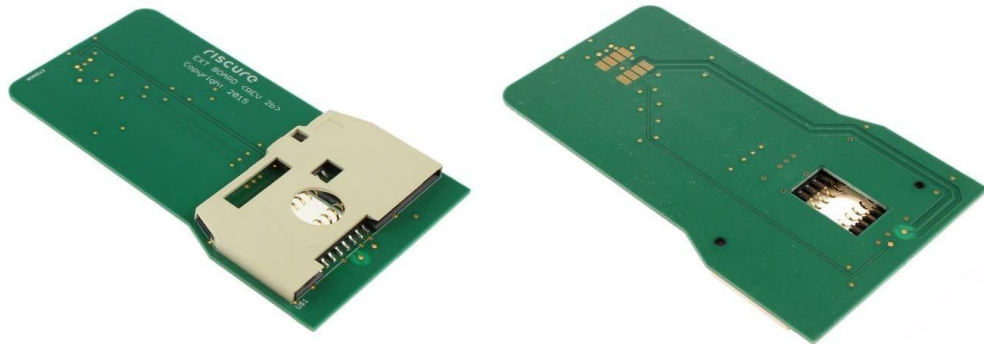
Port	Label	Description
A1	-	LCD display, 2 lines of text for messages.
A2	-	Smart card slot.
B1	signal out	BNC, Buffered output. Power consumption read-out. Usually connected to a channel on a digital storage scope.
B2	reset out	BNC, Buffered output. Duplicated signal from smart card pad 2. Optionally connected to a channel on a scope for preview.
B3	IO out	BNC, Buffered output. Duplicated signal from smart card pad 7. Optionally connected to a channel on a scope for preview.
B4	clock out	BNC, Buffered output. Duplicated signal from smart card pad 3.

Optionally connected to a channel on a scope for preview.

B5	trigger out	BNC, Buffered output. Configurable synchronization signal. Usually connected to a trigger port on a digital storage scope.
C1	power out / RS-232	PS2. Proprietary port for probe hardware.
C2	usb	Control connection with computer.
C3	15VDC	Power supply in.

Extension board

The Smartcard Power Tracer comes with a smart card extension board (thickness 0.8 mm). This board can carry the smart card and can be inserted into the card slot. The board enables (EM) probing experiments which require physical access to the smart card.



Legacy interface

For backward compatibility, the Smartcard Power Tracer has a PS2 port with proprietary wiring for attaching a 12 V probe power supply and a serial communication connection.

The Smartcard Power Tracer can pass commands from USB port to the target on the RS-232 port.

Figure 12 Probing a smartcard while not using the RS232 interface

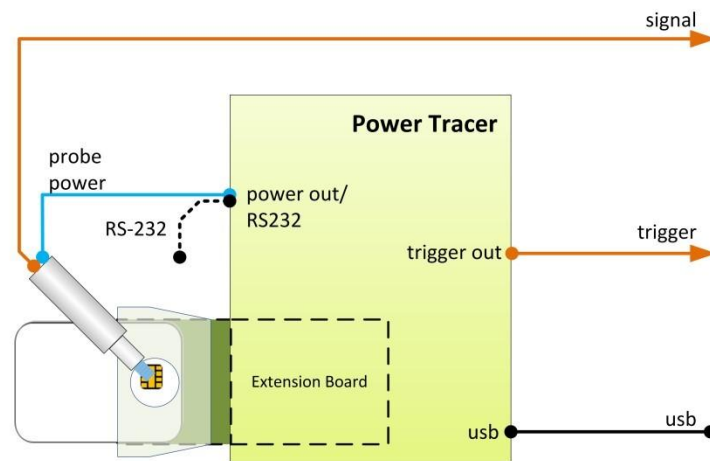
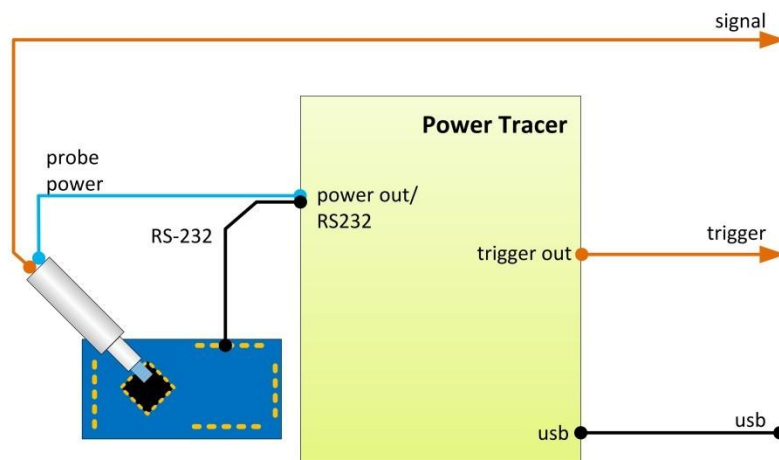


Figure 13 Probing an embedded target while communicating via the RS232 interface



Safety Instructions

WARNING

Only the power adapter which was delivered with the device can be used.

CAUTION

The device cannot be serviced, it needs to be returned to Keysight to be repaired.

CAUTION

The device does not contain any serviceable parts. If something is broken or malfunctioning, it needs to be returned to Keysight for repair.
