



# TWP 16 TC

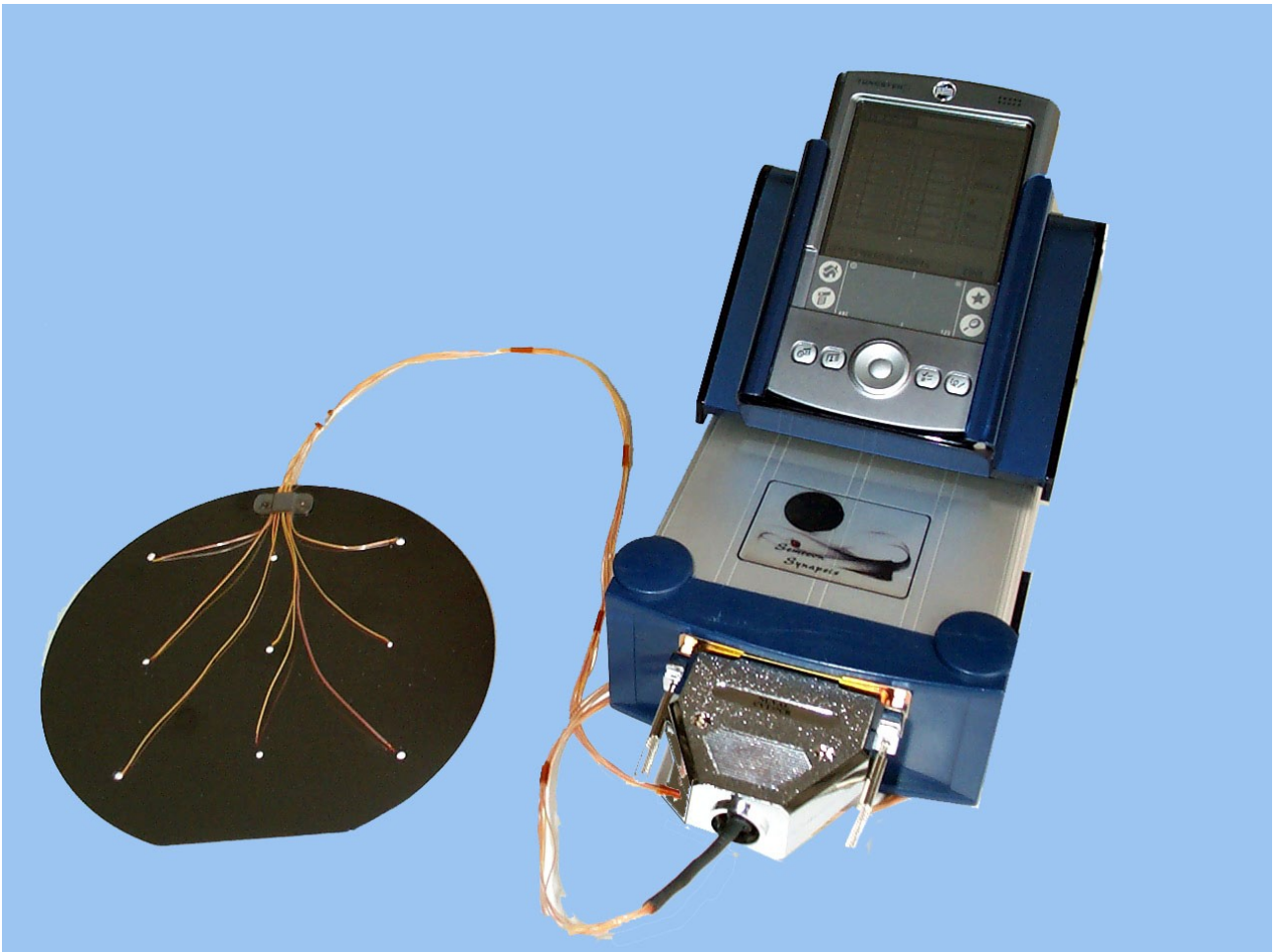
Multi channel wafer temperature profiler

User Manual  
Rev. 1.2  
July 2006



TWP 16

# THERMAL WIRELESS PROFILER FOR SILICON WAFERS



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## 1. Introduction

TWP 16 (Thermal Wireless Profiler) is a measurement and data logging system dedicated to temperature measurement for semiconductor process setup.

This system has the important feature that data display and recording is performed on a handheld terminal which is connected to the main amplifier unit by a wireless Bluetooth system.

This solution has the advantage to allow the operator to freely move into the workshop area and will avoid stress to the wafer probe connections.

The system is completed by the instrumented wafer probe. This wafer can have up to 16 thermocouple sensors which are mounted directly into its surface, to have a more precise indication of process parameters. It is also possible to connect single probes through a connection adapter, but in this case the wafer map will not be displayed and the system will act as a conventional data logger.

The system is composed (excluding the probe) by two main units and by the accessories. The two units are the thermocouple amplifier (connected to the probes) and the handheld terminal, which is a conventional hand held computer with the data logging and communication program.

Accessories are the two power supplies, the SD memory card, the SD card reader for PC data download and all the cables.

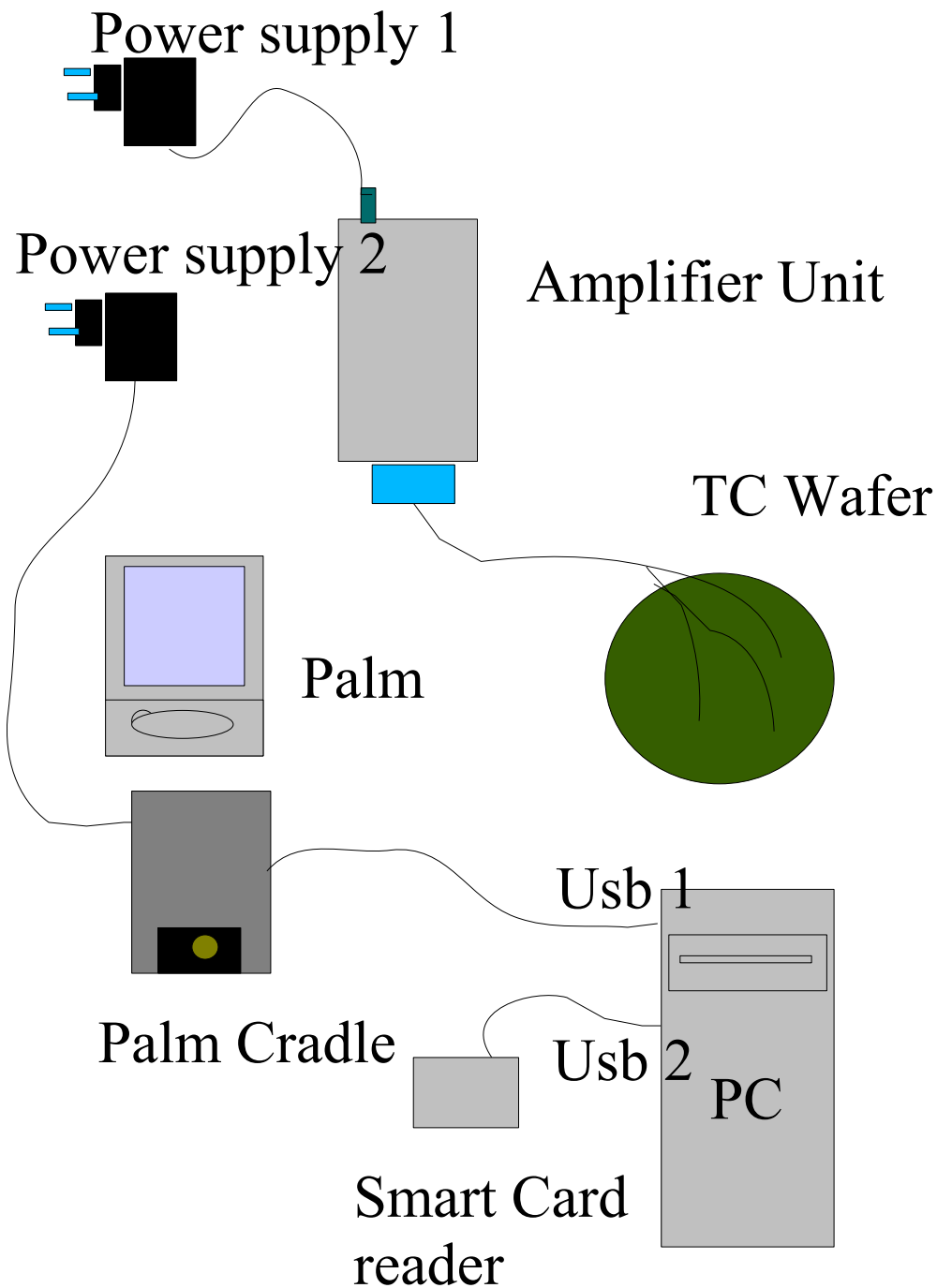
Special accessories such as connection adapters to different types of thermocouple probes can be supplied on request.

## 2. Connections and startup

Connections between the units can be of two different kinds: for measurement end for the accessories.

Measurement connection is simply the connection between instrumented wafer and amplifier unit. The unit can be connected or not to the power supply.

A general connection diagram is represented in the following:



**ATTENTION:** Connection diagram of the Palm handheld can be different from model to model, refer to Palm instruction manual for details

**Fig. 1 System connections**

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### 3. Measurement startup

After having connected all the units and verified that all the batteries are fully charged (if not it is possible to connect power suppliers) switch the amplifier ON by the switch placed on the back side.

It is necessary to leave the amplifier switched on for at least 30 minutes to allow the inner temperature to stabilize, before starting a measurement session. This is needed to avoid measurement errors due to internal temperature differences.

After this time, switch on the Palm terminal and tap with the stylus on the TC wafer program icon.

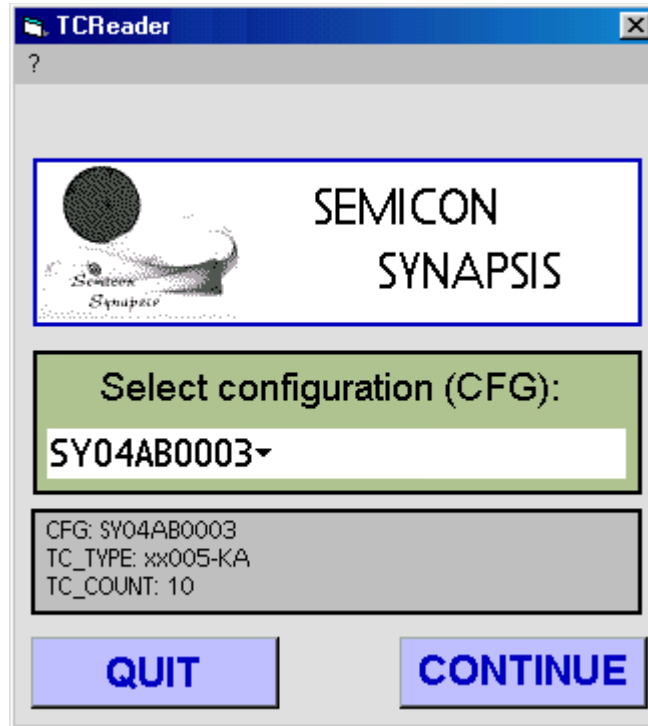
Program will start with the following screen:



After some seconds the main menu page will be displayed:

There are three main parts for the user:

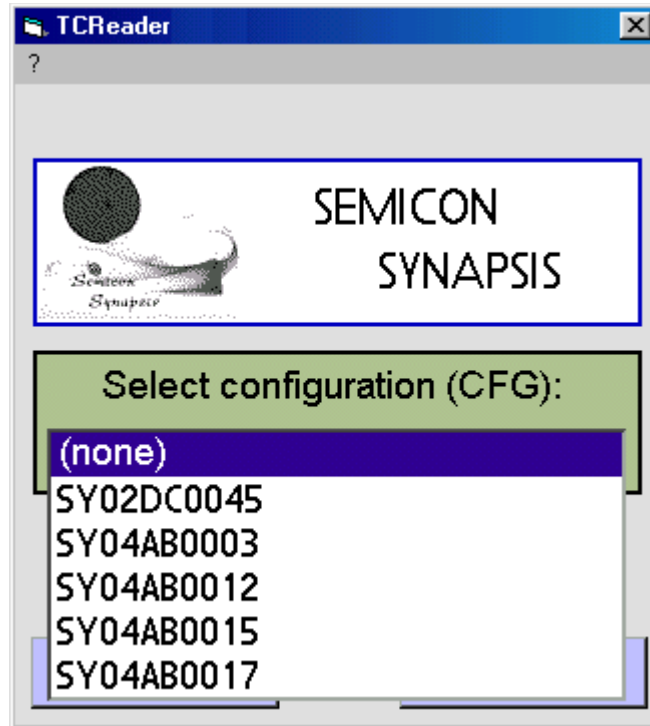
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- A configuration selection section;
- An information bar with the data about the used configuration, the type of thermocouples used and the number of probes on the wafer;
- A command section with the two buttons “QUIT” and “CONTINUE”

By tapping the button QUIT with the stylus, program will be quit.

In this page (configuration selection section) it is possible to select the type of wafer used for the measure. Tap on the bar with configuration name and select the name into the pull down menu opened, by tapping on the name of the configuration to be used.

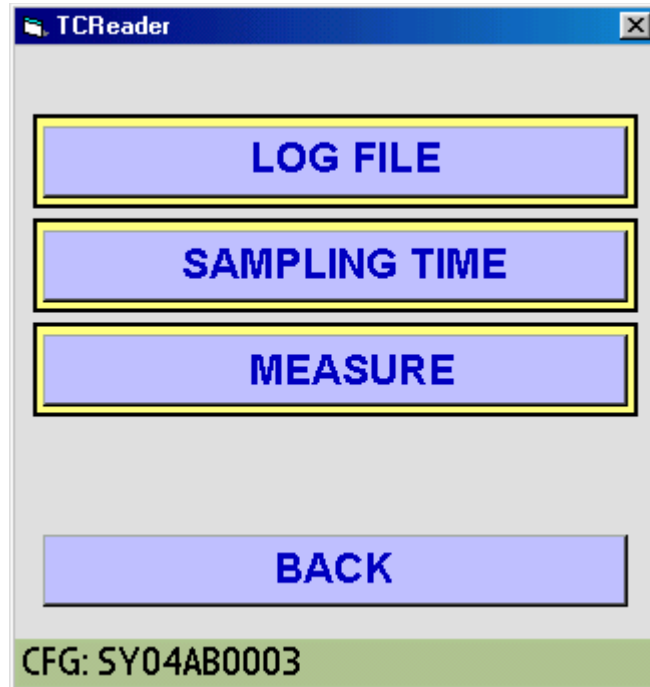


When a configuration is loaded, the screen will automatically return to the previous menu.

If the amplifier is used in connection with general thermocouples (not mounted on a wafer) select NONE on the menu. In this case it will not be possible to display the wafer map (since no wafer map will be available) but it will be possible only to read the thermocouple table or the single probe.

To proceed with measurement, tap on CONTINUE button.

Now the following screen will be displayed:



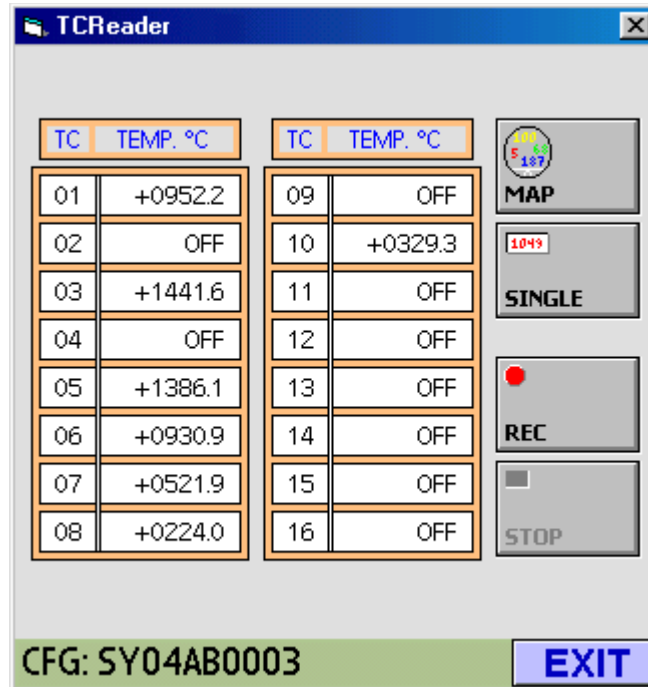
To proceed with temperature measurement, tap on MEASURE button.

In this case the reach of the Bluetooth device is started. IN case more than one Bluetooth units are in the range of the terminal (such as cell phones, printers or other...) select the one identified with WTC nnn (nnn is the serial number).

Answer OK to all the questions from the connection program utility and wait for the temperature display table.

WARNING: if from the configuration menu you have choose NONE, and there are no probes connected to some of the input channels, such channels will display a value depending on the



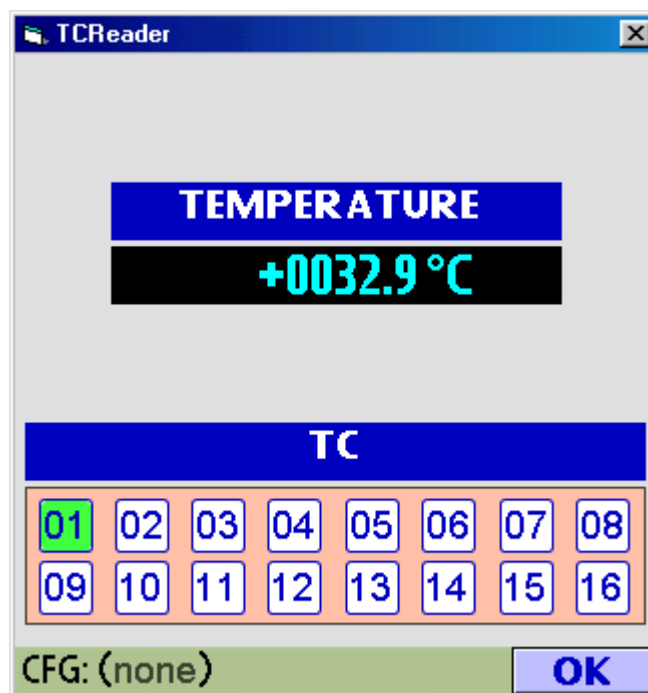
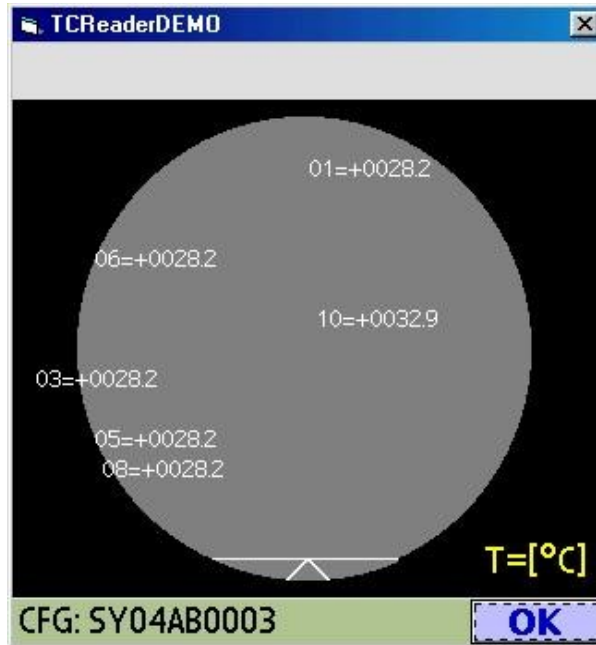


internal temperature of the amplifier (measured by the internal compensation sensor). Please take care when measuring temperatures near to the environmental (it is easy in this case to make confusion with the open channels). This will happen also when a channel has an open junction (a damaged thermocouple).

There are two additional display possibilities, such as the wafer map display and display a single channel.

These two modes are accessible from this screen by tapping on the two buttons MAP and SINGLE.

The two following screens will be displayed



The selection of a the channel to show can be done by tapping on channel number.



On both screens (MAP and SINGLE) pressing the OK button will open again the channel table screen.

## 4. Configurations

There are two different types of configurations used by the system.

The first one is chosen by the operator and represents the topology of the used wafer (positions, number and type of probes and wafer identification code).

The second is normally not to be accessed or modified and is the instrument calibration file.

### 4.1 Wafer configuration

Wafer configuration is the definition of how the used instrumented wafer is built.

Different configurations (one for each wafer type used) can be stored as different files into the SD memory card, into the **TC\TCReader\configs\** folder.

This file must have the **.cfg** extension and has a format defined in the following:

TC\_TYPE= K, T, J, ecc.... Type of thermocouple used (just memo field)

TC\_COUNT= 1-16 number of probes mounted, from 1 to 16

01=n1 position of the first thermocouple on the wafer

02=n2.....position of the second thermocouple

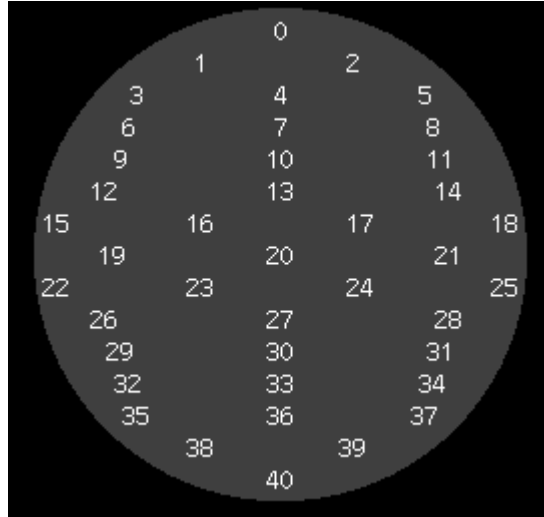
.....

.....

16=n16 position of the 16<sup>th</sup> thermocouple

**ATTENTION: If a configuration file contains definition errors, it will not be displayed into the configuration list.**

To define the position of each thermocouple, there is a reference grid represented into the following figure:



**WARNING: this is the logical grid used into the program: TO OBTAIN THE RIGHT NUMBER FOR EACH POSITION; ADD 1 TO THE GRID NUMBERS**

Into the file the used channels must be identified with the channel number, while not used channels must be identified with 0 .

Example: we have a wafer with a single thermocouple, placed into wafer center and connected to amplifier channel # 3, in this case the number of thermocouples will be 1, all the channels will be identified with 0 except for the # 3 which will be 03=21.

Configuration files can be edited by a PC, working on the SD card through the card reader given, or directly on the hand held terminal working with the “**File Explorer**” utility program.

## 4.2 Calibration file

This file must be modified only in case of instrument calibration needs.

It is stored into the SD memory card, into the **TCVTCReader\offset.tcr** position

The format of this file is the following:

01= offset1

02= offset2

....

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....

16= offset16

The positions from 1 to 16 are the input channels, while offset values, in °C with 1 decimal and sign are the differences between the reference value and the measured value for each channel.

To prepare this file use the following procedure:

Put the amplifier into a room with a constant temperature from 21 to 23 °C, switch it ON and wait for at least 30 minutes to stabilize the inner temperature.

Put to 0 all the offset into the calibration file.

Use a thermocouple calibrator (if possible certified) giving a reference temperature value to the channel and take a note of the temperature measured from each channel.

For each channel take the difference from the given value to the read value (with the right sign) and put this value into the channel offset.

**ATTENTION: THIS IS A CRITICAL OPERATION AND MUST BE PERFORMED ONLY BY SPECIALIZED PERSONNEL WITH THE RIGHT INSTRUMENTS.**

## 5.0 LOG files

This temperature profiler can be used also as a data logger, recording on the SD memory card measurement sessions data.

The resulting file is in .csv format, and can be directly imported into a spreadsheet compatible with Excel program.

The informations written into the file are date and time of recording start and stop, sampling time used, some additional informations like operator name and type of tool and, of course, the temperature read from each channel at each sampling identified with the seconds elapsed from the beginning of measurement session (or the OFF status if the channel is not configured on the used wafer).

The needed data to setup log file information and sampling time will be modified in the first logfile screen, by pressing the proper button.

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The two screens will be as follows:

TCReader

OPERATOR

Smith

MACHINE

AZX-03289

OK

CFG: SY04AB0003

TCReader

SAMPLING TIME

0,5 [sec]

OK

CFG: SY04AB0003



Information fields can be set by writing on the dedicated area on the handheld terminal screen (see the “graffiti” function on the Palm menu), while sampling time can be set tapping on the UP/DOWN arrows and choosing the desired value.

Data recording will then be started by pressing the button REC from the temperature table display.

Once data recording is started, it will be possible to access map display screen or single channel mode, but it will not be possible to exit the measurement mode without having stopped recording.

In case communication errors will occur during measurement, data recording and the logfile will be immediately closed.

Log files can be opened from a PC, putting the SD memory card into the memory reader given as an accessory, and are stored into the **TC\TCReader\logfiles** folder. It is also possible to open such files by the **File Explorer** utility program on the Palm terminal.



## 6. Metrology considerations

The principle used to measure temperature with thermocouples is based on the effect of voltage generation into a junction between two different metals as a function of temperature.

There are different types of thermocouples (T, K, J, R....) depending on the type of metals used and on the response of junction versus temperature.

It is important to remember some technical details when dealing with such type of measures.

First of all, each measure can be affected by accuracy problems given by “hidden junctions” into the measurement chain, due for example to soldering joints, internal connectors and so on.

This fact is the explanation why we have an offset like already mentioned into the point 4.2 of this manual, and also about the need of temperature stabilization of the instrument before starting a measurement session.

Like all instruments of this type, the used amplifiers has an internal compensation of temperature, but if the instrument have to be used as a calibration tool for production processes, it will be a good practice use it at a room temperature of  $21 \pm 1^\circ\text{C}$  and after 30 minutes of stabilization with the amplifier switched on to obtain the best results.

The reachable precision are a maximum of 0.1% referred to the maximum of the used scale, which means  $\pm 1,2^\circ\text{C}$  (with K thermocouples maximum temperature will be around  $1200^\circ\text{C}$ , so 0.1% is  $1.2^\circ\text{C}$ ), while zero and maximum drift are eliminated by the practice of measuring in a constant temperature environment.

Thermocouple probes has also a precision characteristic.

To obtain a precise and reliable measure, when a high precision is needed, a good practice is calibrating the instrument and thermocouples more or less each year, by using certified primary references or instruments. Calibration data can be then used to correct offset file to have directly a precise measure on the instrument.

Of course it must be taken in account that the maximum reachable precision is the sum of the largest differences given by the instrument and by the probe used.





## 7. Parameters

Please take a note of the parameters related to the different used wafer probes and offset data, to have a reference for precise measures.

PARAMETER	VALUE	COMMENTS
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## 8. Utility programs and Errors

Together with the main program (**TCReader**), on the Palm device, three additional utility programs are supplied.

The first is “**FileExplorer**”, which is a minimal editor to read and modify files into the memory card.

This program can be used to modify configuration files and offset file or to display data log files, even if it is recommended, if possible, to do so on a PC with the memory card reader connected.

The second utility program is “**TCBattery**”, used to display the level of the amplifier unit battery.

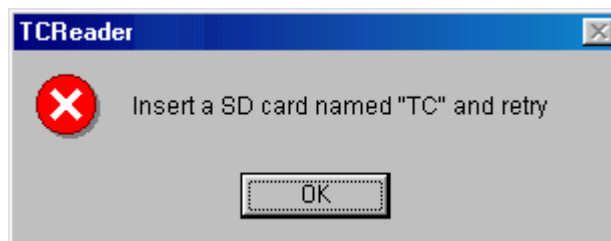
The last of such programs is “**TC7018test**” which gives the direct access to the internal thermocouple amplifiers. This utility is for service only, and should not be used by the normal user.

Error conditions which can occur during the use of temperature profiler are of three main categories:

- problems with memory card
- communication problems
- thermocouple probes problems.

### MEMORY CARD PROBLEMS

If memory card has problems, which means it is missing, badly formatted or damaged, at program startup the following message will be displayed:



If memory card is full, a “data error” is displayed when data recording is started.

In this case, use “File Explorer” utility or a PC to clean up the SD memory card from the unused or



old files to free enough space and retry.

It is advisable to download files and clean memory card at each measurement session to avoid filling up memory.

A memory card with 32 Mb of total space is able to store up to about 10 hours of data recording, with 16 channels active at 1 second of sampling time.

## **COMMUNICATION ERRORS**

The second class of malfunctions is given by communication errors. Such errors are due to different reasons.

First of all, the Bluetooth wireless transmission has a limited distance range and outside this range communication will drop. The maximum range is around 20 m, but can be reduced in case of obstacles or shielding structures in between the two units connected.

As a second possibility, there will be communication errors if the amplifier unit is switched OFF for any reason.

Another possibility to have problems is when amplifier battery goes under the minimum voltage allowed. In this case Bluetooth connection will be found, but amplifiers are no longer able to set the connection active.

The last possibility to have problems is given by electromagnetic interferences which can be present into the environment. Even if Bluetooth channels are reliable enough, they are in any case high frequency, very low power connections and can be affected by interferences.

In case of communication errors of any kind measurement session is stopped, and the same is for data recording, if active, and an error message is displayed.

For any communication error it is generally enough to restart the measurement (and then the communication). If this is not enough, disconnect the external power supplier, if connected to the amplifier, and switch OFF and then ON the amplifier prior to restart measure.

If the error remains, may be the Palm have to be restarted by pressing the RESET button with the tip of the stylus and restart the whole program.

If communication errors were due to heavy interferences it is possible that Bluetooth communication password have lost. In this case it is requested to input a password (any character) and confirm with OK before starting communication.



## THERMOCOUPLE PROBLEMS

Problems due to thermocouple probes can be mainly of two different reasons, or the use of a wrong type of probe or a connection interruption to a channel.

The first case is when the reader is configured for a type of thermocouple (the standard version is for K type probes) and a different type is connected, such as T, R, J or other. When this happens, the value measured is wrong and it is needed to replace the probe with the right type.

The second case is when there is an interruption into the wiring to the probe or into the junction.

The displayed temperature will be in this case the value measured by the internal compensation sensor (usually a value around 25-27 °C) and will remain almost constant while other channels changes.

In this case the probe used must be repaired or substituted with a good one.

It is also possible to use the wafer with a damaged probe, by eliminating the damaged channel from the configuration (of course the number of channels displayed will be lower). To do this refer to the configuration section of this manual (section 4.1).



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## NOTE