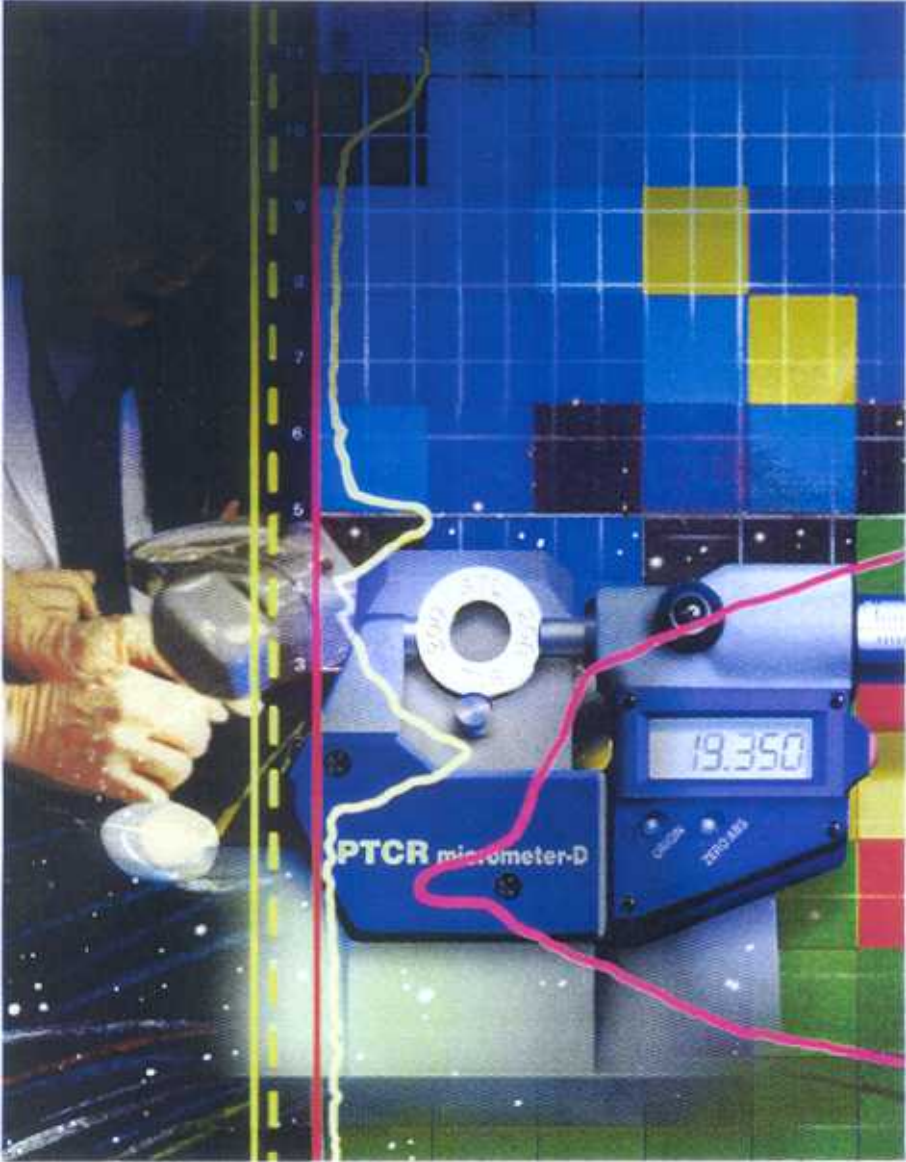


# Process Temperature Control Rings

Higher quality products and lower costs through improved, reliable firing control

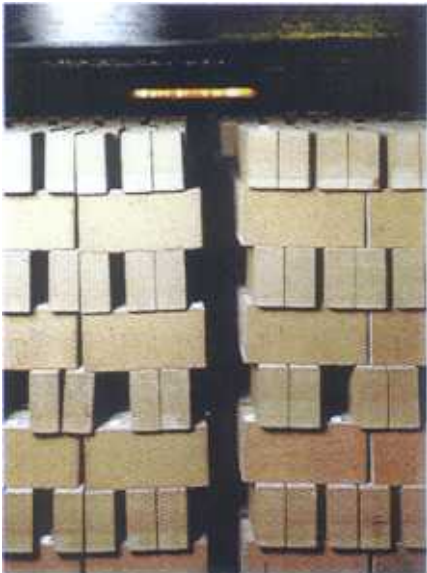


## Take control of your firing process

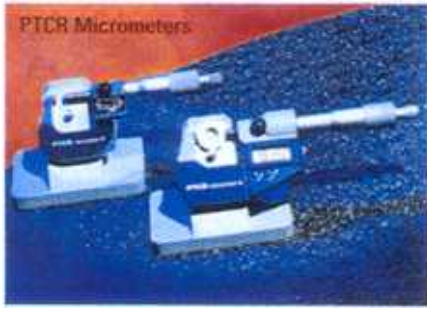
In the manufacture of ceramic products, few things are as critical as accurate control of the firing process. After all, the results have a direct effect on the quality - and the costs - of the final product.

Optimal firing control requires both accurate measurement of the heat treatment - the temperature and its effect over time - together with the ability to control the temperature and the uniformity of its distribution throughout the kiln. Effective temperature measurement is the key to guaranteed product quality.

Most conventional temperature measurement techniques are limited both in time and in location. For example, the thermocouples generally used in the ceramic industry do not measure the temperature of the product itself, but that of its vicinity. They are also limited to measuring radiated heat, and take no account of heat transferred from kiln furniture.







The multifunctional PTCR concept comprises  
 o improved ceramic PTCR rings  
 o improved, convenient packaging  
 o the PTCR micro-meter with numerical or digital read-out  
 & a batch-specific temperature table

## Process Temperature Control Ring

### PTCR: What it is

The Process Temperature Control Ring, PTCR, is a highly accurate ceramic temperature indicator which records the true heat treatment received by the fired product. PTCR rings take account of both radiated and transferred heat, as well as the effects of temperature over time. It conveniently allows this recorded heat exposure to be expressed as a single number - ring temperature (RT) - which is practical and easy to work with.

PTCR rings can be used in both batch and continuous tunnel kilns-, they are used in a range of atmospheres\*. Five different PTCR types are available - in heights of 3.5 and 7.0 mm - covering a range from 850 to 1750°C (1562 to 3182°F). Ring types are identified by color coding and batch and type numbers pressed into the ring.

Originally PTCR has been developed for in- house application in critical firing processes for advanced electronic ceramic components. Now, the PTCR brings the benefits of easy, accurate kiln temperature measurement to a wide range of industries.

### PTCR: How it works

When exposed to heat in the kiln, the PTCR ring contracts - and continues contracting as the top temperature is maintained over time. The degree of contraction is almost linear over the complete operating range of the PTCR, providing a practical measure of the accumulated heat to which the ring - and the fired products - have been subjected.

The amount of contraction - the amount by which the ring diameter has shrunk - is measured with a numerical or digital micrometer. This measurement can be

converted to 'ring temperature' for ease of comparison and correlation to the firing process.

### PTCR: Quality you can rely on

PTCR is recognized for its accuracy and reliability, and its recently improved technology now offers an unsurpassed accuracy guarantee: a maximum variation of no more than 3°RT \*\*

This reliability is based on a stringent manufacturing process. PTCR rings are made from a mix of high-grade materials. Their composition is fine-tuned through advanced Design Of Experiments-(DOE) techniques, and the production process itself is controlled by Statistical Process Control. In fact, the entire PTCR manufacturing facilities have been awarded the internationally recognized ISO 9001:2000 and ISO 14001 quality certification.

Available range of Process Temperature Control Rings (PTCR)

Temperature range	Order no.	Selection of industries applying the PTCR
850 - 1100°C [1562 - 2012°F]	PTCR-ETH PTCR-ETL	LTCC cofiring, building bricks and roofing tiles.
970 - 1250°C [1778 - 2282°F]	PTCR-LTH PTCR-LTL	Pre-sintering ceramics and powders, earthenware, building bricks and roofing tiles, low temperature refractories and kiln furniture.
1130 - 1400°C [2066 - 2552°F]	PTCR-STH PTCR-STL	Single and multi- layer capacitors, ferrites and insulators, powder injection moulding, sanitaryware, table ware and tiles, grinding wheels, medium temperature refractories and kiln furniture.
1340 - 1520°C [2444 - 2768°F]	PTCR-MTH PTCR-MTL	Ferrites, substrates and insulators, tiles and hard porcelain, engineering ceramics, medium - high temperature refractories and kiln furniture.
1450 - 1750°C [2642 - 3182°F]	PTCR-HTH PTCR-HTL	Advanced ceramics, engineering ceramics, high temperature refractories and kiln furniture.

PTCR ring dimensions: outer diameter 20 mm; inner diameter 10 mm; height 7.0 mm (order no. ends with 'H') or 3.5 mm (order no. ends with 'L')

Available range of PTCR micrometers

Order no.	Micrometer type
4322 020 19582	Numerical (N)
4322 020 19583	Digital (D)

\* In case of vacuum, reductive and nitrogen conditions, please contact our Customer Service and Order Desk for more information.

\*\* For detailed information see data sheet

## PTCR in practice: accuracy and convenience

### Firing process optimization

In the process of establishing a standard, the firing process is characterized by 'mapping' the ring temperatures of PTCR rings distributed throughout the kiln. This allows the 'hot' and 'cold spots' to be detected and defined.

Using the heat treatment mapping, the firing process can then be optimized by offsetting heat sources or thermocouples as indicated by the variations in ring temperatures. As a rule of thumb, one degree of ring temperature corresponds to one degree Celsius. The exact relationship between ring temperature and degrees Celsius is of course dependent upon the specific firing cycle of the kiln.

The adjoining illustration shows two heat treatment mappings of the same 15m<sup>3</sup> kiln.

The first was generated before using the PTCR- the second, after firing process optimization using PTCR rings, resulting in substantial yield improvement.

### Firing process control

In the course of time - as a result of aging of the heating elements or frequently alternating firing cycles - 'hot' and 'cold spots' may gradually return to the kiln.

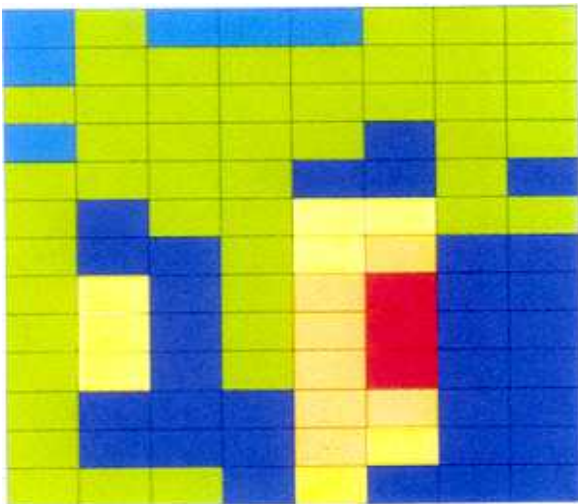
The PTCR can help here, too. Once the firing process has been optimized, PTCR rings can be used regularly to monitor the firing process and to detect these deviations as they gradually arise, before they affect product quality.

By comparing the current ring temperatures against the defined standard, the number of degrees of ring temperature by which the firing process must be adjusted can be determined. Using several rings at critical locations in the kiln ensures that an even heat distribution is maintained.

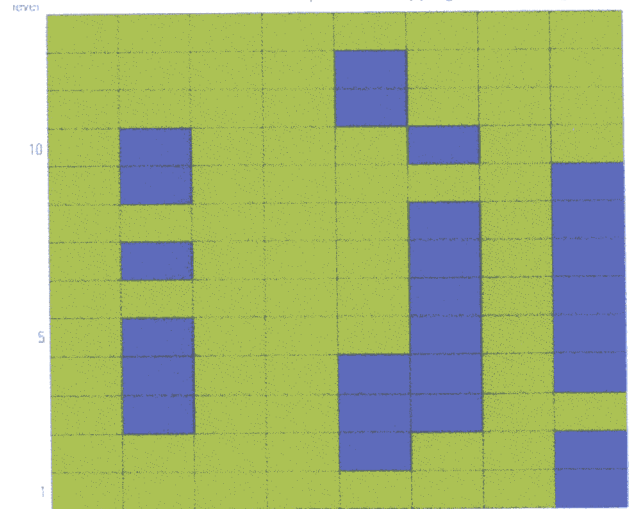
### Quality control at lower cost

Besides the benefits of yield improvement through optimization of the firing process, the PTCR can also help reduce production costs. Simple comparison of ring temperature against a quality standard indicates whether the products are sintered to specification. Expensive, time-consuming conventional quality checks - destruction testing, geometry, density and porosity tests - can be reduced or eliminated.

Kiln temperature mapping **BEFORE** using PTCR



Kiln temperature mapping **AFTER** using PTCR



### Ring-temperature

1095-1099°C	■
1100-1104°C	■
1105-1109°C	■
1110-1114°C	■
1115-1119°C	■
1120-1124°C	■

# Method of use

## Positioning

PTCR rings can be placed at almost any location in the kiln, on kiln furniture, trolleys or transports. The use of both multi-location and multi-level positioning is recommended, as this provides the most insight into the heat treatment distribution within the kiln.

## Measuring

The contraction of the PTCR diameter reflects the actual heat treatment at the point where the ring was located in the kiln. The diameter is easily measured using a PTCR micrometer - only a single measurement is required (as shown).

PTCR micrometers Numerical (N) and Digital (D) have an integral, ergonomically designed solid base with a ring positioning chuck, which ensures the ring is always correctly

positioned in the micrometer. This design not only simplifies the measuring process, but also improves the repeatability and reproducibility of ring temperature measurement.

## Converting to ring temperature

The measured ring diameter is converted to ring temperature using the conversion table enclosed in each packing unit. Each table is specific to the particular batch of rings, for accuracy and convenience.

The ring temperature is a practical single number which is useful for comparison purposes - for instance to relate the recorded heat treatment to the firing process and defined standards - so that any required adjustments can be made. It does not necessarily reflect the actual kiln

temperature- the PTCR acts as an accumulator, measuring the total heat treatment over time, rather than the maximum temperature attained.

## Establishing a standard ring temperature

In order to make ring temperature comparisons between different firings, a standard ring temperature must be defined. This is done by including PTCR rings in a series of firings, and relating their ring temperatures to the quality of the products produced.

The ring temperature which corresponds to products fired to the correct specifications can be used as the standard.



Correct positioning is essential to allow accurate ring diameter reading in a single measurement. The special PTCR micrometers feature a positioning chuck that assists in placement of the ring, helping ensure that measurement is made correctly - across the middle digits of the ring number.

FERRO ELECTRONIC MATERIALS B.V.



higher quality products and lower costs through improved, reliable firing control

4322 020 04071

1130 - 1400°C

Green

1.20 x 1.0 x 3.5 mm

Temperature Range °C		Ring dia. meter		Ring temp. meter		Ring dia. meter		Ring temp. meter	
mm	°C	mm	°C	mm	°C	mm	°C	mm	°C
18.11	1406*	18.81	1354*	18.11	1292*	18.61	1208*		
18.12	1408*	18.82	1356*	18.12	1294*	18.62	1210*		
18.13	1410*	18.83	1358*	18.13	1296*	18.63	1212*		
18.14	1412*	18.84	1360*	18.14	1298*	18.64	1214*		
18.15	1414*	18.85	1362*	18.15	1300*	18.65	1216*		
18.16	1416*	18.86	1364*	18.16	1302*	18.66	1218*		
18.17	1418*	18.87	1366*	18.17	1304*	18.67	1220*		
18.18	1420*	18.88	1368*	18.18	1306*	18.68	1222*		
18.19	1422*	18.89	1370*	18.19	1308*	18.69	1224*		
18.20	1424*	18.90	1372*	18.20	1310*	18.70	1226*		
18.21	1426*	18.91	1374*	18.21	1312*	18.71	1228*		
18.22	1428*	18.92	1376*	18.22	1314*	18.72	1230*		
18.23	1430*	18.93	1378*	18.23	1316*	18.73	1232*		
18.24	1432*	18.94	1380*	18.24	1318*	18.74	1234*		
18.25	1434*	18.95	1382*	18.25	1320*	18.75	1236*		
18.26	1436*	18.96	1384*	18.26	1322*	18.76	1238*		
18.27	1438*	18.97	1386*	18.27	1324*	18.77	1240*		
18.28	1440*	18.98	1388*	18.28	1326*	18.78	1242*		
18.29	1442*	18.99	1390*	18.29	1328*	18.79	1244*		
18.30	1444*	19.00	1392*	18.30	1330*	18.80	1246*		
18.31	1446*	19.01	1394*	18.31	1332*	18.81	1248*		
18.32	1448*	19.02	1396*	18.32	1334*	18.82	1250*		
18.33	1450*	19.03	1398*	18.33	1336*	18.83	1252*		
18.34	1452*	19.04	1400*	18.34	1338*	18.84	1254*		
18.35	1454*	19.05	1402*	18.35	1340*	18.85	1256*		
18.36	1456*	19.06	1404*	18.36	1342*	18.86	1258*		
18.37	1458*	19.07	1406*	18.37	1344*	18.87	1260*		
18.38	1460*	19.08	1408*	18.38	1346*	18.88	1262*		
18.39	1462*	19.09	1410*	18.39	1348*	18.89	1264*		
18.40	1464*	19.10	1412*	18.40	1350*	18.90	1266*		
18.41	1466*	19.11	1414*	18.41	1352*	18.91	1268*		
18.42	1468*	19.12	1416*	18.42	1354*	18.92	1270*		
18.43	1470*	19.13	1418*	18.43	1356*	18.93	1272*		
18.44	1472*	19.14	1420*	18.44	1358*	18.94	1274*		
18.45	1474*	19.15	1422*	18.45	1360*	18.95	1276*		
18.46	1476*	19.16	1424*	18.46	1362*	18.96	1278*		
18.47	1478*	19.17	1426*	18.47	1364*	18.97	1280*		
18.48	1480*	19.18	1428*	18.48	1366*	18.98	1282*		
18.49	1482*	19.19	1430*	18.49	1368*	18.99	1284*		
18.50	1484*	19.20	1432*	18.50	1370*	19.00	1286*		

## PTCR: a quality product from a quality source

### **Worry-free firing control, day after day**

Ferro places great emphasis on the quality of PTCR rings - after all, the quality of the rings has a direct impact on the quality of our customers' products!

All raw materials used in the powder mix from which the rings are manufactured undergo extensive laboratory testing. The powders are homogenized, and each individual batch is numbered and inspected once more, to guarantee both physical and pressing properties. A unique batch identifier is pressed into each individual ring, allowing any ring to be traced back to its original powder batch, if necessary. As each batch of powder is released, the ring temperature conversion table is calculated - specifically for that batch.

For more information, please contact your distributor or our Customer Service and Order Desk:

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Ferro's unique approach to temperature tables relieves PTCR users of the need to recalibrate or recalculate standard ring temperatures when introducing rings from a new batch. Since each individual PTCR ring can be relied on to perform as specified in the conversion table, absolute accuracy is always assured. The PTCR's accuracy, reliability and convenience free you from the concerns of firing quality and control - allowing you to concentrate on the quality of your product, not on temperature control.

Process Temperature Control Rings: higher quality products and lower costs through improved, reliable firing control.

