

tpi

291

**Digital Clamp-on
Meter *Amp Plus*
Instruction Manual**

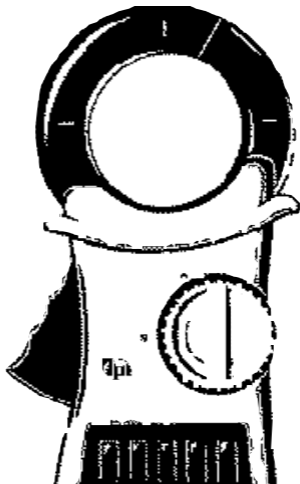


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A. INTRODUCTION

1. Congratulations!!

Thank you for purchasing TPI products. The *Amp Plus* is easy to use and is built to last. It is backed by a 3 year limited warranty. Please remember to complete and return your product warranty registration card.

2. Product Description

The 291 is a hand-held manual ranging clamp-on DMM. The 291 is an affordable choice offering measurements in all basic electrical functions.

- **Bar Graph** When measuring frequency, bar graph indicates current level.
- **Peak Mode** For start-up and inrush currents.
- **Sleep Mode** Preserves battery life.
- **Data Hold** Holds the reading on the display for easy viewing.

The 291 comes complete with the following accessories:

Carrying Pouch
Test Lead Set
Instruction Manual
Battery

3. EC Declaration of Conformity

This is to certify that TPI Model 291 conforms to the protection requirements of the council directive 89/336/EEC, in the approximation of laws of the member states relating to Electromagnetic compatibility and 73/23/EEC. The Low Voltage Directive by application of the following standards:

| | |
|-----------------------|--------------------------------|
| EN 50081-1 | 1992 Emissions Standard |
| EN 50082-1 | 1992 Immunity Standard |
| EN 61010-1 | 1993 Safety Standard |
| EN 61010-2-031 | 1995 Safety Standard |
| EN 61010-2-032 | 1995 Safety Standard |

To ensure conformity with these standard, this instrument must be operated in accordance with the instructions and specifications given in this manual.

CAUTION: Even though this instrument complies with the immunity standards, it's accuracy can be affected by strong radio emissions not covered in the above standards. Sources such as hand-held radio transceivers, radio and TV transmitters, vehicle radios and cellular phones generate electromagnetic radiation that could be induced into the test leads of this instrument. Care should be taken to avoid such situations or alternatively, check to make sure that the instrument is not being influence by these emissions.

CAUTION: Please follow manufacturers test procedures whenever possible. Do not attempt to measure unknown voltages or components until a complete understanding of the circuit is obtained.

B. SAFETY CONSIDERATIONS



WARNING: *Please follow manufacturers test procedures whenever possible. Do not attempt to measure unknown voltages or components until a complete understanding of the circuit is obtained.*

GENERAL GUIDELINES

ALWAYS

- Test the 291 before using it to make sure it is operating properly.
- Inspect the test leads before using to make sure there are no breaks or shorts.
- Double check all connections before testing.
- Have someone check on you periodically if working alone.
- Have a complete understanding of the circuit being measured.
- Disconnect power to circuit, then connect test leads to the 291, then to circuit being measured.

NEVER

- Attempt to measure unknown high voltages.
- Attempt to measure current with the meter in parallel to the circuit.
- Connect the test leads to a live circuit before setting up the instrument.
- Touch any exposed metal part of the test lead assembly.

INTERNATIONAL SYMBOLS

 **CAUTION: RISK OF ELECTRIC SHOCK**

 **AC (Alternation Current)**

 **DC (Direct Current)**

 **REFER TO INSTRUCTION MANUAL**

 **GROUND**

 **DOUBLE INSULATION**

 **EITHER DC OR AC**

C. TECHNICAL DATA

1. Features and Benefits

Agency UL Listed to U.S. and Canadian Safety Standards. Meets CE and IEC 1010.

4000 Count Improves the resolution on all functions and ranges.

Data Hold Maintains the reading on the display for hard to reads areas.

Peak Mode Measure the inrush current of motors, relays and solenoids.

Sleep Mode Automatically powers down after 10 minutes of inactivity.

2. Product Applications

Perform the following tests and/or measurements with the 291 and the appropriate function:

HVAC/R

- ACA** • Heat anticipator current in thermostats.
- ACV** • Line voltage.
- ACV or DCV** • Control circuit voltage.
- OHMS** • Heating element resistance (continuity).
- OHMS** • Compressor winding resistance.
- OHMS** • Contactor and relay coil resistance.
- ACA** • Motor and compressor start up current.
- OHMS** • Continuity of wiring.
- ALL** • Bar graph to indicate rapid fluctuations.

ELECTRICAL

- ACV** • Measure line voltage.
- ACA** • Measure line current.
- OHMS** • Continuity of circuit breakers.
- DCV** • Voltage of direct drive DC motors.
- ACA** • Start up current of motors, relays, contactors and transformers.

ELECTRONIC

- ACV** • Measure power supply voltage.
- ACA** • Measure power supply current.
- OHMS** • Continuity of circuit breakers and fuses.

3. Specifications



IEC 1010 Over Voltage:

CAT II - 1000V

CAT III - 600V

Pollution Degree 2



a. DCV


| Range | Resolution | Accuracy | Impedance |
|-------|------------|---------------------------------|-----------|
| 40V | 0.01V | ±0.75% of reading, ±3 digits | 10MΩ |
| 400V | 0.1V | | |
| 600V | 1V | | |

b. ACV

| Range | Resolution | Accuracy | Impedance |
|-------|------------|--------------------------------|-----------|
| 400V | 0.1V | ±1.2% of reading, ±3 digits | 10MΩ |
| 750V | 1V | | |

c. ACA

| Range | Res. | Accuracy | Freq. Response |
|-------|------|--------------------------------|----------------|
| 400A | 0.1A | ±1.5% of reading, ±4 digits | 45Hz to 450Hz |
| 700A | 1A | | |

 ***Warning:** Test Leads. Use only correct type and overvoltage category rating.

e. OHM (Resistance,)

| Range | Res. | Accuracy | Overload Protection |
|-------|------|----------------------------|---------------------|
| 400Ω | 0.1Ω | ±1% of reading, ±10 digits | 600V DC or AC Peak |

f. Continuity Buzzer

| Test Voltage | Threshold | Over Load Protection |
|--------------|--------------------|----------------------|
| 3V | < 50Ω (100 digits) | 600 V DC or Peak AC |

h. General Specifications

| | |
|--|--|
| Max. Volt. between any Input and Ground | 600V |
| Display Type | 4,000 Count, 4 times per second update |
| Operating Temp. | -10° to 45°C (14° to 113°F) |
| Storage Temp. | -20° to 55°C (-4° to 131°F) |
| Relative Humidity | 0% to 80% (0° - 35°C/32° - 95°F) 0% to 70% (35° - 50°C/95° - 122°F) |
| Power Supply | 9 Volt Battery |
| Battery Life | 80 hrs. Alkaline |
| Size (H x L x W) | 40mm x 190mm x 65mm (1.5in x 7.25in x 2.5in) |
| Weight | 315g (11.1oz) |

D. MEASUREMENT TECHNIQUES

1. Controls and Functions:

Push Buttons

- PEAK** Activates the Peak Hold function (ACA only.)
- HOLD** Holds the reading on the display until the button is pushed a second time.

Rotary Switch

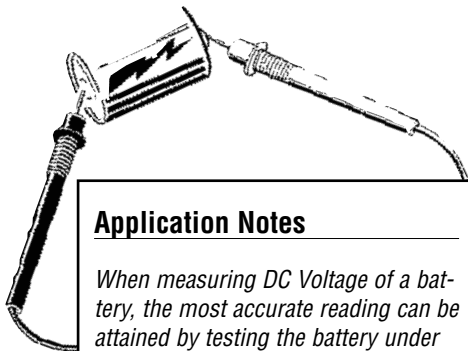
- OFF** Turns the 291 completely off.
- $\overline{\text{V}}$** Used to measure DC volts.
- $\tilde{\text{V}}$** Used to measure AC volts.
- $\Omega \bullet \text{)))$** Used to measure resistance and use the continuity buzzer.
- $\tilde{\text{A}}$** Used to measure AC amps.

1. Controls and Functions: (cont.)

Input Jacks

COM Black test lead connection for ACV, DCV, Ω , Continuity Buzzer and Diode Test functions.

V/ Ω Red test lead connection for all ACV, DCV, Ω , Continuity Buzzer and Diode Test functions.



Application Notes

When measuring DC Voltage of a battery, the most accurate reading can be attained by testing the battery under load. To accomplish this, follow steps 1 through 4 shown on page 13 and the following (with the battery in holder and device turned on):

- *Connect the red test lead from the meter to the positive (+) terminal of the battery.*
- *Connect the black test lead to the negative (-) terminal of the battery.*
- *Reconnect power to the circuit and read the voltage on the 291.*

2. Step by Step Procedures:

a. Measuring DC Volts

WARNING!

Do not attempt to make a voltage measurement of more than 600V or of a voltage level that is unknown.

Instrument set-up:

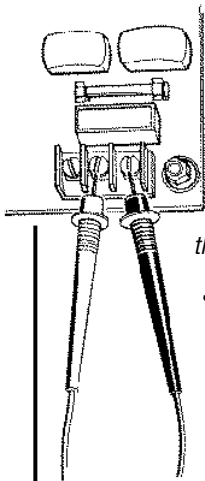
| FUNC. | BLACK TEST LEAD | RED TEST LEAD | MIN READING | MAXI READING |
|-----------------------|-----------------|---------------|-------------|--------------|
| $\overline{\text{V}}$ | COM | V/ Ω | 0.1mV | 750V |

Measurement Procedure:

1. Disconnect power to circuit to be measured.
2. Plug black test lead into the **COM** input jack.
3. Plug red test lead into the **V/ Ω** input jack.
4. Set rotary switch to the appropriate $\overline{\text{V}}$ range.
5. Connect test leads to circuit to be measured.
6. Reconnect power to circuit to be measured.
7. Read the voltage on the 291.

Optional Modes

- **HOLD:** Freezes the reading on the LCD.
- **PEAK:** Measures the peak voltage.



Application Notes

Disconnect power from the terminal block, find the fuse or circuit breaker that controls the block and turn it off.

Set up the meter following the steps under "Measurement Procedure" on page 15. Then proceed with the following:

- Connect the red test lead to the hot side of the block and the black lead to the neutral side of the block. Reconnect power to the block and read the voltage on the meter. The reading should be approximately 110V to 130V.*
- Disconnect power from the block and move the red wire to ground. Reconnect power to the block and read the voltage on the meter. Typically less than 20V should exist from neutral to ground. If 110V or above exists, the block may be wired incorrectly.*

b. Measuring AC Volts

WARNING!

Do not attempt to make a voltage measurement of more than 600V or of a voltage level that is unknown.

Instrument set-up:

| FUNC. | BLACK TEST LEAD | RED TEST LEAD | MIN READING | MAX READING |
|-------------|-----------------|---------------|-------------|-------------|
| \tilde{V} | COM | V/ Ω | 0.1mV | 750V |

Measurement Procedure:

1. Disconnect power to circuit to be measured.
2. Plug black test lead into **COM** input jack.
3. Plug red test lead into **V/ Ω** input jack. \tilde{V}
4. Set the rotary switch to the appropriate **V** function.
5. Connect test leads to circuit to be measured.
6. Reconnect power to circuit to be measured.
7. Read the voltage on the 291.

Optional Modes

- **HOLD:** Freezes the reading on the LCD.
- **PEAK:** Measures the peak voltage.

c. Measuring AC Amps

CAUTION!

Do not attempt to make a current measurement with the test leads. The 291 measures the current by clamping the jaw around one conductor (wire). Clamping around more than one wire will result in erroneous readings.

Instrument set-up:

| FUNC. | BLACK TEST LEAD | RED TEST LEAD | MIN READING | MAX READING |
|--------------|------------------------|----------------------|--------------------|--------------------|
| \tilde{A} | NOT USED | NOT USED | 0.01A | 700A |

Measurement Procedure:

1. Disconnect power to circuit to be measured.
2. Set rotary switch to \tilde{A} function.
3. Clamp the jaws around one conductor of the circuit to be measured.
4. Reconnect power to circuit to be measured.
5. Read the current on the 291.

Optional Modes

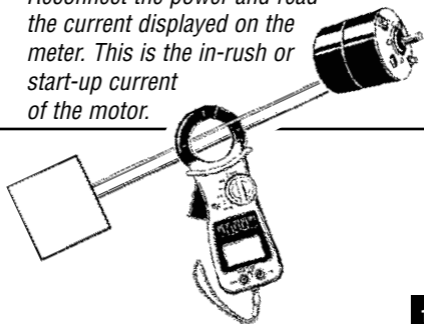
- **HOLD:** Freezes the reading on the LCD.
- **PEAK:** Measures the peak amperage.

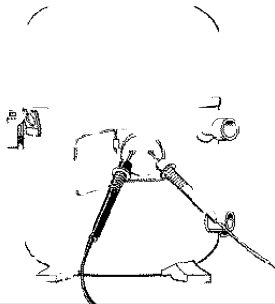
Application Notes

When measuring AC Amps of a motor there are two types of measurements that can be made, running current and in-rush or start-up current. Start-up current will usually be much higher than running current.

Set up the meter following the steps under "Measurement Procedure" on page 16, and then proceed with the following:

- Clamp the meter around a single wire and reconnect power to the device. Read the current displayed on the meter. This is the running current of the motor.*
- Disconnect power to the motor and put the meter in PEAK HOLD mode. Reconnect the power and read the current displayed on the meter. This is the in-rush or start-up current of the motor.*





Application Notes (Resistance)

When measuring resistance of a motor, make sure the power is disconnected prior to testing.

Set up meter following steps under "Measurement Procedure" on page 19, and proceed with the following:

- *Connect the red test lead to one power input line of the motor and the black test lead to the other power input line of the motor. In most applications if the reading is OFL, the motor winding is open.*
- *Connect the red test lead to the frame of the motor and the black test lead to the winding. In most applications if a reading of 0 Ohms is displayed, the winding is shorted to the motor frame (ground).*

d. Measuring Resistance


WARNING!

Do not attempt to make resistance measurements with circuit energized. For best results, remove the resistor completely from circuit before attempting to measure it.

NOTE:

To make accurate low ohm measurements, short the ends of the test leads together and record the resistance reading. Deduct this value from actual readings.

Instrument set-up:

| FUNC. | BLACK TEST LEAD | RED TEST LEAD | MIN READING | MAX READING |
|--|-----------------|---------------|--------------|--------------|
| Ω  | COM | V/ Ω | 0.1 Ω | 400 Ω |

Measurement Procedure:

1. Disconnect power to circuit to be measured.
2. Plug black test lead into the **COM** input jack.
3. Plug red test lead into **V/ Ω** input jack.
4. Set the rotary switch to the **400 Ω** function.
5. Connect test leads to circuit to be measured.
6. Read the resistance value on the 291.

Optional Modes

- **HOLD:** Freezes the reading on the LCD.

e. Continuity Buzzer

WARNING!

Do not attempt to make continuity measurements with circuit energized.

Instrument set-up:

| FUNC. | BLACK TEST LEAD | RED TEST LEAD |
|------------|-----------------|---------------|
| Ω • | COM | V/ Ω |

Measurement Procedure:

1. Disconnect power to circuit to be measured.
2. Plug black test lead into the **COM** input jack.
3. Plug red test lead into **V/ Ω** input jack.
4. Set the rotary switch to the Ω • function.
5. Connect test leads to circuit to be measured.
6. Listen for the buzzer to confirm continuity.

Optional Modes

- **HOLD:** Freezes the reading on the LCD.

f. Data Hold

Press the **HOLD** button at any time on any function to freeze the reading on the LCD display. This function is very useful when measuring in locations where the display is difficult to read.

g. Peak Mode

Set the 291 to either the 400 or 700 ACA range and allow the reading on the LCD to settle down to zero. Clamp the jaw around one wire of the device the peak current is to be measured from and again allow the LCD to settle down to zero. Apply power to the device and read the initial current draw by the device being measured.

E. ACCESSORIES*

| Standard Accessories | Part No. |
|-----------------------------|-----------------|
| 9 Volt Alkaline Battery | A009A |
| Test Lead Set | A040 |
| Soft Carrying Pouch | A200 |

| Optional Accessories | Part No. |
|-------------------------------|-----------------|
| Deluxe Test Lead Set | SDK1C |
| IEC 1010 Deluxe Test Lead Kit | TLS2000BC |
| Hard Carrying Case | A201 |

*These accessories have not been evaluated by UL and are not considered as part of the UL Listing of this product.

F. MAINTENANCE

1. **Battery Replacement:** The 291 will display a battery symbol when the internal 9 Volt battery needs replacement. The battery is replaced as follows:
 - a. Disconnect and remove all test leads from live circuits and from the 291.
 - b. Loosen the screw from the back of the 291 battery cover.
 - c. Remove the battery compartment cover.
 - d. Remove old battery and replace with new battery, observing the correct polarity.
 - e. Reassemble the instrument in reverse order from above.

2. **Cleaning your 291:**

Use a mild detergent and slightly damp cloth to clean the surfaces of the 291.

WARRANTY

Please refer to product warranty card for warranty statement.

G. TROUBLE SHOOTING GUIDE

Problem

Probable Causes

Does not power up

- Dead or defective battery
- Broken wire from battery snap to PCB

Won't display current readings

- Open fuse
- Open test lead
- Improperly connected to circuit under test

All functions except ohms read high

- Very weak battery that will not turn on the low battery indicator on the LCD

AC Volts do not read

- Very weak battery that will not turn on the low battery indicator on the LCD

291 SPECIFICATIONS

±0.75% Basic DCV Accuracy (also see pages 8-9)

| <u>Func.</u> | <u>Range</u> | <u>Res.</u> |
|-------------------|---------------------------|---|
| DCV | 40V | 0.01V |
| | 400V | 0.1V |
| | 600V | 1V |
| ACV | 400V | 0.1V |
| | 750V | 1V |
| ACA | 400A | 0.1A |
| | 700A | 1A |
| OHM | 400Ω | 0.1Ω |
| Continuity | <u>Test Voltage</u> 3V | <u>Max Test Current</u> < 50Ω (100 digits) |



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