

# AC/DC Current Measurement Systems

## TCPA300 • TCP312 • TCP305 • TCP303 • TCPA400 • TCP404XL Data Sheet



### Features & Benefits

- AC/DC Measurement Capabilities
- DC – 100 MHz, Current Probe Amplifier (TCPA300) uses:
  - DC – 100 MHz, 30 A DC (TCP312)
  - DC – 50 MHz, 50 A DC (TCP305)
  - DC – 15 MHz, 150 A DC (TCP303)
- DC – 50 MHz, Current Probe Amplifier (TCPA400) Uses:
  - DC – 2 MHz, 750\*1 A DC (TCP404XL) (500 A DC Continuous)
- Automatic Scaling and Units\*2 – Oscilloscope On-screen Readout of Magnitude and Amps reduces Measurement Errors with No More Hand Calculations
- AC/DC Input Coupling
- Low Insertion Impedance reduces Device Under Test Loading
- Split-core Construction allows Easy Circuit Connection

- Status Indicators provide Visual Operating Status and Notification of Potential Error Conditions – Degauss, Probe Open, Overload, Not Terminated into 50  $\Omega$ , Noncompatible Probe Type
- Lower DC Drift and Noise allows Improved Low-level Current Measurements
- Certified for use in U.S., Canada, and Europe. Complies with applicable IEC Standards.

### Applications

- Development and Analysis Solutions for Designers, Installers, and Service Personnel in Telecomm, Data Comm, Computer, and Semiconductor Power Electronics Environments for:
  - Power Supplies (Switching and Linear)
  - Semiconductor Devices (SCRs, IGBTs, MOSFETs, CMOS, BJTs)
  - Power Inverters/Converters
  - Electronic Ballasts
  - Industrial/Consumer Electronics
  - Mobile Communications (Phone, Satellite, Relay Stations)
  - Motor Drives
  - Transportation Systems (Electronic Vehicles, Electric Trains, Locomotives, Avionics)

### Increased Performance and Simplicity

The TCP300 and TCP400 Series AC/DC current measurement family is a highly advanced current measurement system for today's current measurement needs. When connected to Tektronix oscilloscopes with TEKPROBE Level II, TekConnect (w/ TCA-BNC), or TekVPI (w/ TPA-BNC) interfaces, current measurements and calculations are simple and easy.

\*1 Derated with duty cycle.

\*2 Requires a TDS TEKPROBE oscilloscope or a TekConnect oscilloscope with TCA-BNC.

## Meets Today's AC/DC Current Measurement Applications

The TCPA300 amplifier, when used with TCP312, TCP305, or TCP303 probes, provides a wide range of current measurement capability and spans the gap between low-level milliamp measurements to very high current levels. These three probes provide current measurement capabilities of 30 A, 50 A, and 150 A DC continuous. For even higher current levels, the TCPA400 amplifier with the TCP404XL current probe measures 500 A DC continuous and 750 A DC continuous, derated with duty cycle.

Higher frequency performance is available with the TCP312 w/TCPA300 providing  $\geq 100$  MHz bandwidth and a maximum current of 30 A DC.

## Measurement Errors and Manual Calculations are Now a Thing of the Past

With this new series of current measurement tools, automatic control and on-screen scaling and units is provided for users of Tektronix TDS3000, TDS500, TDS600, TDS700, TDS5000, TDS6000, and TDS7000B Series oscilloscope systems (the DPO3000, DPO4000, and DPO7000 Series oscilloscopes, the TPA-BNC adapter is required).

The TCP300/TCP400 current measurement systems seamlessly integrate with your TDS Series oscilloscope.

Even non-TEKPROBE systems can use the TCPA300/400 Series to make proper current measurements by simply multiplying the measured output voltage on the oscilloscope by the TCPA300/400 Series range setting.

## Characteristics

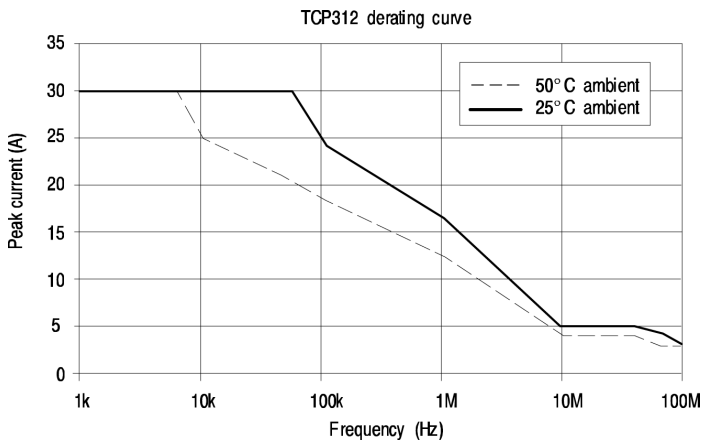
| Characteristic                                             | TCP312 w/ TCPA300                                                                                       | TCP305 w/ TCPA300                                                            | TCP303 w/ TCPA300                                                                  | TCP404XL w/ TCPA400                                                                                      |
|------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------|------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------|
| Bandwidth (–3 dB)                                          | DC – 100 MHz                                                                                            | DC – 50 MHz                                                                  | DC – 15 MHz                                                                        | DC – 2 MHz*3                                                                                             |
| Rise Time                                                  | $\leq 3.5$ ns                                                                                           | $\leq 7$ ns                                                                  | $\leq 23$ ns                                                                       | $\leq 175$ ns                                                                                            |
| Maximum Current Ratings:                                   |                                                                                                         |                                                                              |                                                                                    |                                                                                                          |
| High-current Sensitivity Range                             | 10 A/V Range                                                                                            | 10 A/V Range                                                                 | 50 A/V Range                                                                       | 1 A/mV Range                                                                                             |
| DC (Continuous)                                            | 30 A                                                                                                    | 50 A                                                                         | 150 A                                                                              | 500 A (750 A*4)                                                                                          |
| RMS (Sinusoidal)                                           | 21.2 A                                                                                                  | 35.4 A                                                                       | 150 A                                                                              | 500 A                                                                                                    |
| Peak Pulse                                                 | 50 A                                                                                                    | 50 A                                                                         | 500 A                                                                              | 750 A                                                                                                    |
| Low-current Sensitivity Range                              | 1 A/V Range                                                                                             | 5 A/V Range                                                                  | 5 A/V Range                                                                        | N/A                                                                                                      |
| DC (Continuous)                                            | 5 A                                                                                                     | 25 A                                                                         | 25 A                                                                               | N/A                                                                                                      |
| RMS (Sinusoidal)                                           | 3.5 A                                                                                                   | 17.7 A                                                                       | 17.7 A                                                                             | N/A                                                                                                      |
| Peak Pulse                                                 | 50 A                                                                                                    | 50 A                                                                         | 500 A                                                                              | N/A                                                                                                      |
| DC Accuracy<br>(Operating temp 0 °C to 50 °C)              | $\pm 3\%$ of reading                                                                                    | $\pm 3\%$ of reading                                                         | $\pm 3\%$ of reading (10 °C to 50 °C)<br>$+3\%/-6\%$ of reading (0 °C to $<10$ °C) | $\pm 3\%$ of reading                                                                                     |
| DC Accuracy, Typical<br>(Operating temp 23 °C $\pm 5$ °C)  | $\pm 1\%$ of reading                                                                                    | $\pm 1\%$ of reading                                                         | $\pm 1\%$ of reading                                                               | $\pm 1\%$ of reading                                                                                     |
| <b>Nominal</b>                                             |                                                                                                         |                                                                              |                                                                                    |                                                                                                          |
| Maximum Bare Wire Voltage                                  | For use with insulated wires only                                                                       |                                                                              | 600 V <sub>RMS</sub> CAT I & II<br>300 V <sub>RMS</sub> CAT III                    |                                                                                                          |
| Lowest Measurable Current<br>(at $\pm 3\%$ accuracy at DC) | 1 mA                                                                                                    | 5 mA                                                                         | 5 mA                                                                               | 1 A                                                                                                      |
|                                                            | Scope set to 1 mV/div and 20 MHz BW Limited                                                             |                                                                              | Scope set to 1 mV/div and 20 MHz BW Limited                                        |                                                                                                          |
| Insertion Impedance<br>(See curves below)                  | 0.08 $\Omega$ at 1 MHz<br>0.15 $\Omega$ at 10 MHz<br>0.27 $\Omega$ at 50 MHz<br>0.7 $\Omega$ at 100 MHz | 0.035 $\Omega$ at 1 MHz<br>0.12 $\Omega$ at 10 MHz<br>0.4 $\Omega$ at 50 MHz | 0.01 $\Omega$ at 1 MHz<br>0.025 $\Omega$ at 5 MHz<br>0.1 $\Omega$ at 15 MHz        | 0.1 m $\Omega$ at 10 kHz<br>0.6 m $\Omega$ at 100 kHz<br>8 m $\Omega$ at 1 MHz<br>16 m $\Omega$ at 2 MHz |

| Characteristic                                                   | TCP312 w/ TCPA300                                                                 | TCP305 w/ TCPA300               | TCP303 w/ TCPA300                                                               | TCP404XL w/ TCPA400        |
|------------------------------------------------------------------|-----------------------------------------------------------------------------------|---------------------------------|---------------------------------------------------------------------------------|----------------------------|
| Typical                                                          |                                                                                   |                                 |                                                                                 |                            |
| Maximum Amp-Second Product<br>(Based on Amplifier Range setting) | 50 A*µS – 1 A/V<br>500 A*µS – 10 A/V                                              | 500 A*µS – 5 A/V<br>NA – 10 A/V | 3,000 A*µS – 5 A/V<br>15,000 A*µS – 50 A/V                                      | NA – 1 A/mV                |
| AC-coupling Low-frequency Bandwidth<br>(Low Pass – 3 dB point)   | <7 Hz                                                                             |                                 |                                                                                 |                            |
| Displayed RMS Noise<br>(at 20 MHz bandwidth limit)               | ≤250 µA <sub>RMS</sub>                                                            | ≤1.25 mA <sub>RMS</sub>         | ≤2.5 mA <sub>RMS</sub>                                                          | ≤250 mA <sub>RMS</sub>     |
| Signal Delay (Delay to output BNC)                               | 17 ns                                                                             | 19 ns                           | 40 ns                                                                           | 80 ns                      |
| Inputs (Probe amplifier)                                         | 1                                                                                 |                                 |                                                                                 |                            |
| Probe Open Indicator                                             | Yes                                                                               |                                 |                                                                                 |                            |
| Overload Indicator                                               | Yes                                                                               |                                 |                                                                                 |                            |
| Termination Indicator                                            | Yes                                                                               |                                 |                                                                                 |                            |
| Noncompatible Probe Indicator                                    | Yes                                                                               |                                 |                                                                                 |                            |
| Safety Certifications                                            |                                                                                   |                                 |                                                                                 |                            |
| U.S. NRTL Listing                                                | UL3111-1<br>(Amplifier)                                                           |                                 | UL3111-2-032 ; UL3111-1<br>(Probe and Amplifier)                                |                            |
| Canadian Certification                                           | CAN/CSA C22.2 No.1010.1<br>(Amplifier)                                            |                                 | CAN/CSA C22.2 No.1010.2.032<br>CAN/CSA C22.2 No.1010.1<br>(Probe and Amplifier) |                            |
| European Union Compliance                                        | EN61010-1/A2<br>(Amplifier)                                                       |                                 | EN61010-1/A2; EN61010-2-032<br>EN61010-1/A2<br>(Probe and Amplifier)            |                            |
| Other                                                            | IEC61010-1/A2 (Amplifier)                                                         |                                 | IEC61010-2-032<br>IEC61010-1/A2<br>(Probe and Amplifier)                        |                            |
| Electromagnetic Compatibility                                    | EC Council Directive 89/336/EEC, FCC Part 15, Subpart B Class A, AS/NZS 2064.1/2. |                                 |                                                                                 |                            |
| Power Requirements<br>(TCPA300/TCPA400 Amplifiers)               | 90 V to 264 V; 47 to 440 Hz; 50 W<br>Maximum CAT II (Auto Switch)                 |                                 |                                                                                 |                            |
| Power Requirements (Probes)                                      | Requires TCPA300 Amplifier                                                        |                                 |                                                                                 | Requires TCPA400 Amplifier |
| Probe Model                                                      | TCP312                                                                            | TCP305                          | TCP303                                                                          | TCP404XL                   |
| Warranty                                                         | 1 Year                                                                            |                                 |                                                                                 |                            |
| Probe Mechanical Characteristics                                 |                                                                                   |                                 |                                                                                 |                            |
| Probe Cable Length                                               | 1.5 meters (60 inches)                                                            |                                 | 2 meters (78.7 inches)                                                          | 8 meters (315 inches)      |
| Probe Jaw Size (Max conductor size)                              | 3.8 mm (0.15 inches)                                                              |                                 | 21 mm × 25 mm (0.83 × 1.0 inches)                                               |                            |
| Length                                                           | 20 cm (7.87 inches)                                                               |                                 | 26.8 cm (10.55 inches)                                                          | 26.8 cm (10.55 inches)     |
| Width                                                            | 1.6 cm (0.625 inches)                                                             |                                 | 4.1 cm (1.60 inches)                                                            | 4.1 cm (1.60 inches)       |
| Height                                                           | 3.2 cm (1.25 inches)                                                              |                                 | 15.6 cm (6.13 inches)                                                           | 15.6 cm (6.13 inches)      |
| Weight                                                           | 0.15 kg (0.33 lb.)                                                                |                                 | 0.66 kg (1.45 lb.)                                                              | 0.88 kg (1.90 lb.)         |
| TCPA300 and TCPA400 Mechanical Characteristics                   |                                                                                   |                                 |                                                                                 |                            |
| Length                                                           | 17.3 cm (6.8 inches)                                                              |                                 |                                                                                 |                            |
| Width                                                            | 16.7 cm (6.6 inches)                                                              |                                 |                                                                                 |                            |
| Height                                                           | 9.14 cm (3.6 inches)                                                              |                                 |                                                                                 |                            |
| Weight                                                           | 1.14 kg (2.5 lb.)                                                                 |                                 |                                                                                 |                            |

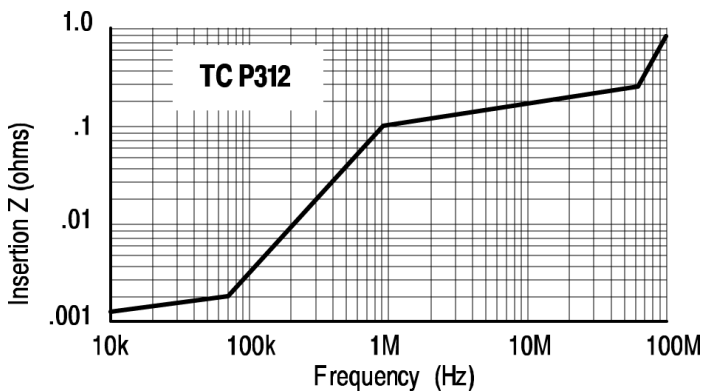
| Characteristic                       | TCP312 w/ TCPA300                                 | TCP305 w/ TCPA300 | TCP303 w/ TCPA300 | TCP404XL w/ TCPA400 |
|--------------------------------------|---------------------------------------------------|-------------------|-------------------|---------------------|
| <b>Environmental Characteristics</b> |                                                   |                   |                   |                     |
| Temperature                          |                                                   |                   |                   |                     |
| Operating                            | 0 °C to +50 °C (32 °F to 122 °F)                  |                   |                   |                     |
| Nonoperating                         | -40 °C to +75 °C (-40 °F to 167 °F)               |                   |                   |                     |
| Humidity                             |                                                   |                   |                   |                     |
| Operating                            | 5% to 95% R.H. to +30 °C (86 °F)                  |                   |                   |                     |
|                                      | 5% to 85% R.H. +30 °C to +50 °C (86 °F to 122 °F) |                   |                   |                     |
| Nonoperating                         | 5% to 95% R.H. to +30 °C (86 °F)                  |                   |                   |                     |
|                                      | 5% to 85% R.H. +30 °C to +75 °C (86 °F to 167 °F) |                   |                   |                     |
| Altitude                             |                                                   |                   |                   |                     |
| Operating                            | 2000 m (6800 ft.) maximum                         |                   |                   |                     |
| Nonoperating                         | 12,192 m (40,000 ft.) maximum                     |                   |                   |                     |

\*3 Calculated from rise time.

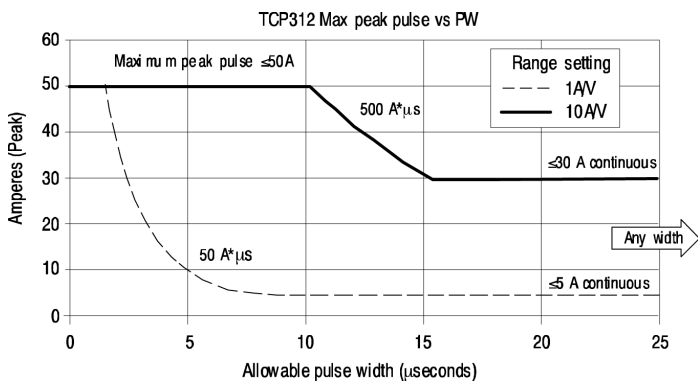
\*4 Derated w/ duty cycle and frequency.



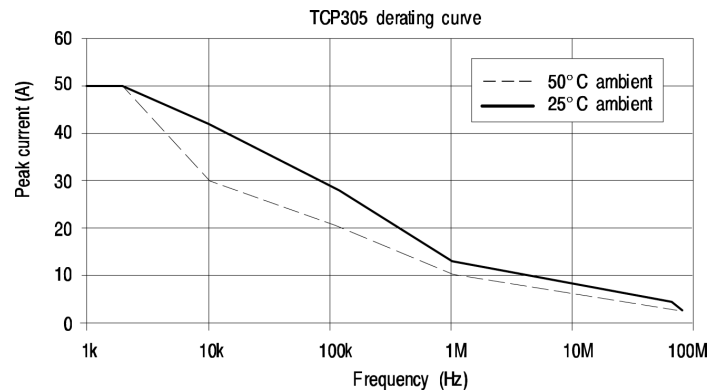
TCP312 Typical Peak Current Frequency Derating Curve.



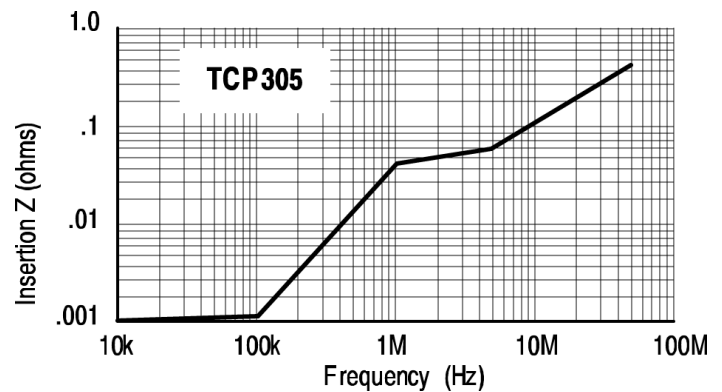
TCP312 Typical Insertion Impedance Curve.



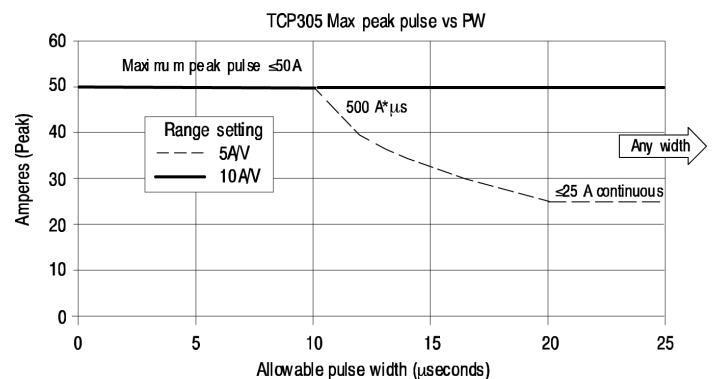
TCP312 Typical Specified Operating Area Characteristics.



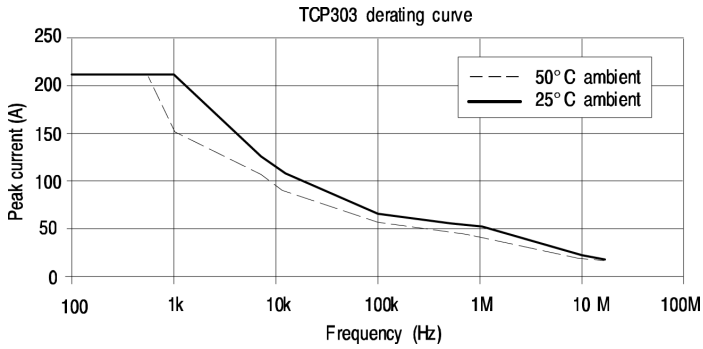
TCP305 Typical Peak Current Frequency Derating Curve.



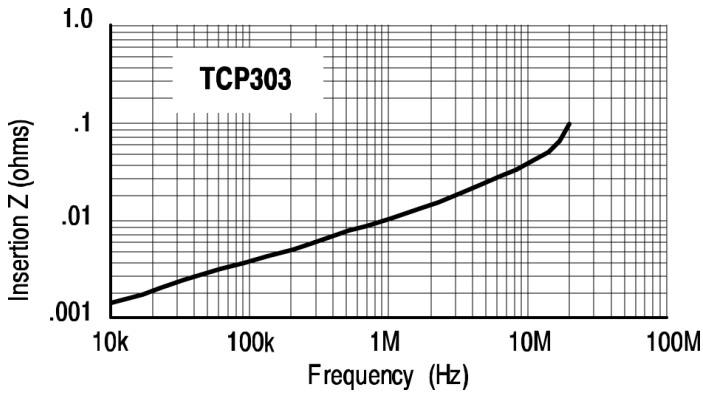
TCP305 Typical Insertion Impedance Curve.



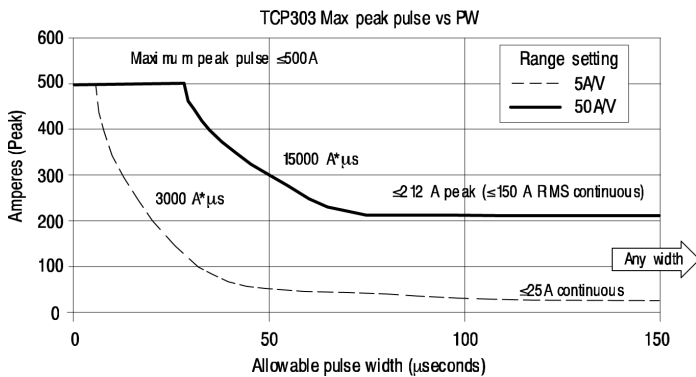
TCP305 Typical Specified Operating Area Characteristics.



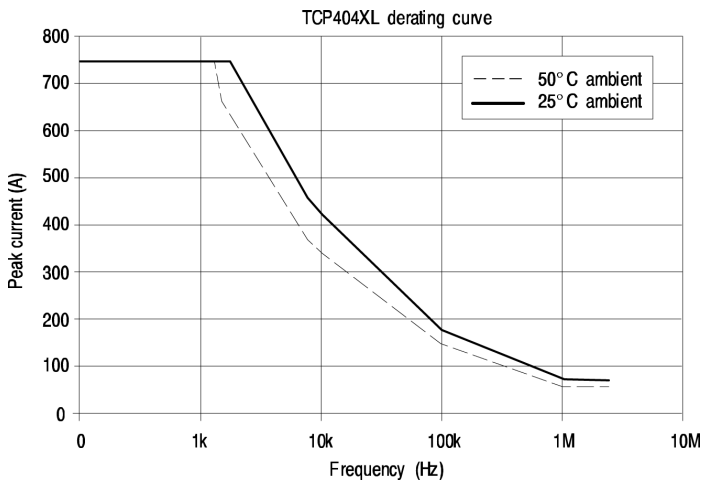
TCP303 Typical Peak Current Frequency Derating Curve.



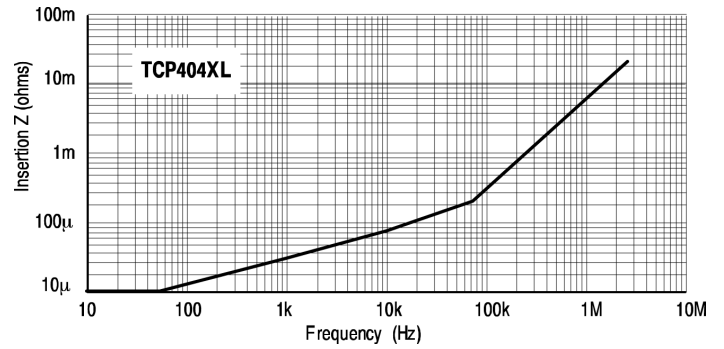
TCP303 Typical Insertion Impedance Curve.



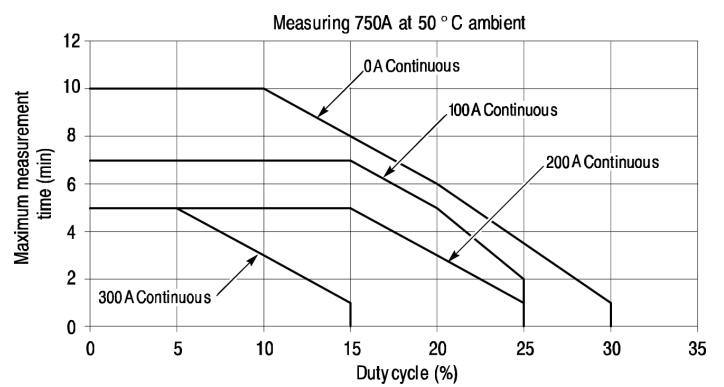
TCP303 Typical Specified Operating Area Characteristics.



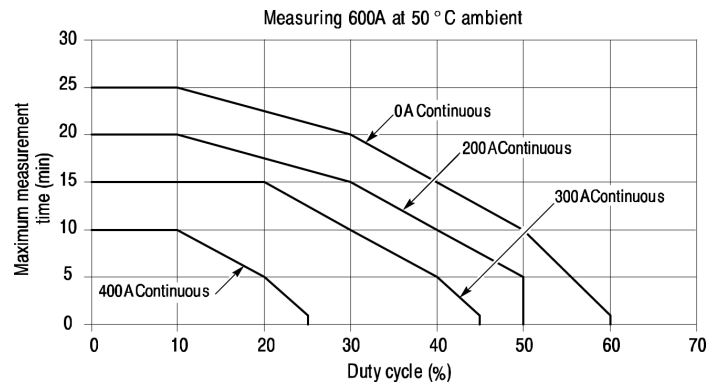
TCP404XL Typical Peak Current Frequency Derating Curve.



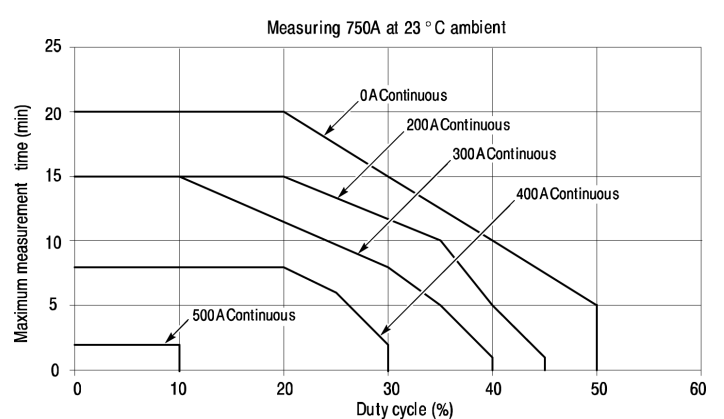
TCP404 Typical Insertion Impedance Curve.



TCP404XL Maximum Current Measurement Time (750 A at 50 °C Ambient).



TCP404XL Maximum Current Measurement Time (600 A at 50 °C Ambient).



TCP404XL Maximum Current Measurement Time (750 A at 23 °C Ambient).

(Note: At 23 °C ambient, 600 A may be measured continuously with the TCP404XL probe.)

## Ordering Information

### Probes

| Product  | Description                                                                                                 |
|----------|-------------------------------------------------------------------------------------------------------------|
| TCP312   | Probe; AC/DC current, DC to 100 MHz; 30 A DC (Requires TCPA300 amplifier)                                   |
| TCP305   | Probe; AC/DC current, DC to 50 MHz; 50 A DC (Requires TCPA300 amplifier)                                    |
| TCP303   | Probe; AC/DC current, DC to 15 MHz; 150 A DC (Requires TCPA300 amplifier)                                   |
| TCP404XL | Probe; AC/DC current, DC to 2 MHz; 500 A DC (750 A DC derated with duty cycle) (Requires TCPA400 amplifier) |

**All TCP300/TCP400 Current Probes Include:** AC/DC current probe, instruction sheet, probe cover, Certificate of Traceable Calibration.

### Amplifiers

| Product | Description                                                                                 |
|---------|---------------------------------------------------------------------------------------------|
| TCPA300 | Amplifier; AC/DC current probe, DC to 100 MHz; (Requires TCP305 or TCP312 or TCP303 probes) |
| TCPA400 | Amplifier; AC/DC current probe, DC to 50 MHz; (Requires TCP404XL probe)                     |

**All TCPA300/TCPA400 Current Probe Amplifiers Include:** AC/DC current probe amplifier, instruction/service manual, TEKPROBE interface cable, Male-to-Male BNC cable (50  $\Omega$ ), 50  $\Omega$  feedthrough termination, Certificate of Traceable Calibration.

### TCPA300/TCPA400

#### Power Plug Options

| Option   | Description          |
|----------|----------------------|
| Opt. A0  | North America power  |
| Opt. A1  | Universal Euro power |
| Opt. A2  | United Kingdom power |
| Opt. A3  | Australia power      |
| Opt. A5  | Switzerland power    |
| Opt. A6  | Japan power          |
| Opt. A10 | China power          |
| Opt. A11 | India power          |
| Opt. A12 | Brazil power         |
| Opt. A99 | No power cord        |

#### Language Options

| Option   | Description     |
|----------|-----------------|
| Opt. L0  | English manual  |
| Opt. L5  | Japanese manual |
| Opt. L10 | Russian manual  |
| Opt. L99 | No manual       |



Protective covers.

### All TCP300/TCPA300/TCP400/TCPA400 Series

#### Service Options

| Option  | Description                                      |
|---------|--------------------------------------------------|
| Opt. C3 | Calibration Service 3 Years                      |
| Opt. C5 | Calibration Service 5 Years                      |
| Opt. D1 | Calibration Data Report                          |
| Opt. D3 | Calibration Data Report 3 Years (with Option C3) |
| Opt. D5 | Calibration Data Report 5 Years (with Option C5) |
| Opt. R3 | Repair Service 3 Years                           |
| Opt. R5 | Repair Service 5 Years                           |

#### Recommended Accessories

| Accessory   | Description                                                                                                                  |
|-------------|------------------------------------------------------------------------------------------------------------------------------|
| 016-1923-00 | Cover, Small Probe Protective; (for TCP305, TCP312, A6302, A6302XL, A6312, TCP202)                                           |
| 016-1924-00 | Cover, Large Probe Protective; (for TCP303, TCP404XL, A6303, A6303XL, A6304XL)                                               |
| 016-1922-00 | Case, Transit; Current Measurement Systems                                                                                   |
| 011-0049-02 | 50 $\Omega$ Feedthrough Termination                                                                                          |
| 012-0117-00 | 50 $\Omega$ BNC-to-BNC Coaxial Cable                                                                                         |
| 012-1605-00 | TEKPROBE Interface Cable, TCPA300 or TCPA400 Amplifier to TDS Series Oscilloscopes                                           |
| 015-0601-50 | Current Loop, 1 Turn, 50 $\Omega$ , BNC Connector (for TCP305, TCP312, A6302, A6302XL A6312, TCP202, TCP303, A6303, A6303XL) |
| 174-4765-00 | TCPA300/TCPA400 Amplifier Calibration Adapter                                                                                |
| 067-1478-00 | Power Measurements Deskew Fixture, for TCP202, TCP305, TCP312, TCP303, A6302, A6312, A6303, Series Probes                    |



Tektronix is registered to ISO 9001 and ISO 14001 by SRI Quality System Registrar.



Contact Tektronix:

- ASEAN / Australasia (65) 6356 3900
- Austria 00800 2255 4835\*
- Balkans, Israel, South Africa and other ISE Countries +41 52 675 3777
- Belgium 00800 2255 4835\*
- Brazil +55 (11) 3759 7627
- Canada 1 800 833 9200
- Central East Europe and the Baltics +41 52 675 3777
- Central Europe & Greece +41 52 675 3777
- Denmark +45 80 88 1401
- Finland +41 52 675 3777
- France 00800 2255 4835\*
- Germany 00800 2255 4835\*
- Hong Kong 400 820 5835
- India 000 800 650 1835
- Italy 00800 2255 4835\*
- Japan 81 (3) 6714 3010
- Luxembourg +41 52 675 3777
- Mexico, Central/South America & Caribbean 52 (55) 56 04 50 90
- Middle East, Asia, and North Africa +41 52 675 3777
- The Netherlands 00800 2255 4835\*
- Norway 800 16098
- People's Republic of China 400 820 5835
- Poland +41 52 675 3777
- Portugal 80 08 12370
- Republic of Korea 001 800 8255 2835
- Russia & CIS +7 (495) 7484900
- South Africa +41 52 675 3777
- Spain 00800 2255 4835\*
- Sweden 00800 2255 4835\*
- Switzerland 00800 2255 4835\*
- Taiwan 886 (2) 2722 9622
- United Kingdom & Ireland 00800 2255 4835\*
- USA 1 800 833 9200

\* European toll-free number. If not accessible, call: +41 52 675 3777

Updated 10 February 2011

**For Further Information.** Tektronix maintains a comprehensive, constantly expanding collection of application notes, technical briefs and other resources to help engineers working on the cutting edge of technology. Please visit [www.tektronix.com](http://www.tektronix.com)



Copyright © Tektronix, Inc. All rights reserved. Tektronix products are covered by U.S. and foreign patents, issued and pending. Information in this publication supersedes that in all previously published material. Specification and price change privileges reserved. TEKTRONIX and TEK are registered trademarks of Tektronix, Inc. All other trade names referenced are the service marks, trademarks, or registered trademarks of their respective companies.

02 Oct 2011

60W-16458-5

