



John Chubb Instrumentation Ltd  
Unit 30, Lansdown Industrial Estate, Gloucester Road,  
Cheltenham, GL51 8PL, UK. Tel: +44 (0)1242 573347  
Fax: +44 (0)1242 251388 email: [jchubb@jci.co.uk](mailto:jchubb@jci.co.uk)

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# **USER MANUAL: JCI 178 Charge Measurement Unit**

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# USER MANUAL: JCI 178 Charge Measurement Unit

*for general measurement of small quantities of charge and measurement of charge transfer in static discharges.*

## 1. INTRODUCTION

The JCI 178 is a compact and easy to use instrument for the sensitive measurement of charge in the range 10pC to 200nC. The unit is shown in Figure 1. The unit incorporates a 3½ digit liquid crystal display showing directly the quantity of charge transfer measured in nano-coulombs (nC). It has an analogue output for remote display and recording of readings with opportunity for remote zeroing. For measurement of charge transfer in electrostatic discharges the unit can be fitted with a JCI 179 shielded probe. This ensures that observations can be interpreted with confidence [1,2] and valid judgements made on the risk of ignition presented in relation to quantities of charge transferred.

## 2. PRACTICAL DESIGN FEATURES

The charge measurement unit has many of the same physical design features as the JCI 140 Static Monitor instrument. It is thus easy to handle, to control and to read the values from observations.

The unit is based on a 'virtual earth' charge measurement circuit. As this ensures the input remains essentially at earth potential insulation leakage problems are minimised. Circuit design features, such as guarding, minimise zero drift and droop of readings.

Two ranges of sensitivity are available. These are selected by the 3 position slide switch in the back cover of the instrument. This provides selection as: OFF/ON(20nC FSD)/ON(200nC FSD). When the instrument is operating on its most sensitive range the sensitivity can be changed to its second, lower sensitivity, range remotely by shorting pin 4 of the 8w mini-DIN to earth – yellow lead.

A small push button is provided in the back cover for zeroing readings before observations. No zero setting adjustment is provided so it is necessary (and always wise) to take note of the 'zero' reading after the zeroing button has been released and just before charge is received. Note that with sensitive charge measurements it is desirable to hold the unit in the 'zeroing' state until just before measurements are made. This will reduce the chance of any zero drift.

The back cover also includes a combination 'Durable Dot'/'4mm bayonet pin' earth bonding connector, an 8w min DIN connector and a 2.1mm 12V external power supply input connection. The 8w miniature DIN connector provides for analogue output of observations, input of external power supply and opportunity for zeroing with a remote push button. The instrument must be bonded to earth for meaningful measurements.

An audio alarm is included with a user settable threshold level. This may help recognition of untoward charge generation situations and identification of hazardous discharges in practical testing.

## 3. ARRANGEMENTS FOR MEASUREMENT

Connection to the source of charge to be measured is made via the BNC connector on the front end panel of the unit. This may be linked directly to the charge source or via a low noise coaxial cable. Care needs to be taken that no significant quantity of charge is generated by flexure or vibration of a connecting cable.

The display and analogue output readings are zeroed by pressing the 'zeroing' push button in the rear panel of the instrument or using the appropriate connections to the 8w mini DIN connector in the back panel. Zeroing involves shorting the charge measurement feedback capacitor of the virtual earth charge sensing input circuit. At this time the input is isolated from the preamplifier. If there is some appreciable capacitance in the charge source then it may be

useful to re-zero a few times to get a good low zero reading. For sensitive measurements it is best to hold the circuit in a zeroed condition until a measurement is to be made. The zero should be released a short time (a few seconds) before a measurement is made so that a good value of the zero reading and any drift is obtained from which to evaluate observations. In preparing for practical studies (for example with a Faraday Pail) it is wise to check for drift of zero and droop of finite charge readings from the system before taking measurements.

#### **4. JCI 179 DISCHARGE PROBE**

Charge transfer measurements in spark type electrostatic discharges need to be made using a shielded probe such as the JCI 179[1,2]. The JCI 179 probe is a general purpose shielded probe, and this can be mounted directly on the input BNC connector of the JCI 178. The input for the virtual earth amplifier is buffered with a capacitor earth to avoid overloading the output drive capability of this amplifier. The circuits of the JCI 178 are not specially fast so they will not resolve any fast steps in the rising edge of a charge transfer but they will show correctly the overall quantity of charge transferred. Observations may usefully be recorded using a digital storage oscilloscope – for instance a Picoscope.

#### **5. CALIBRATION**

The sensitivity of charge measurement may be calibrated [3] by charging a calibrated quality capacitor to a calibrated voltage and discharging this to the instrument input. Because the input is to a virtual earth preamplifier all the charge ( $Q = C V$ ) will be transferred and used as a basis for instrument calibration. For example, a 10nF 1% polystyrene capacitor charged to 1.0V is a convenient arrangement for providing 10nC of charge. (See also Calibration section on JCI Website).

Since the JCI 178 used a virtual earth charge measurement circuit an alternative approach is to provide calibrated quantities of charge on the basis of switching a defined current into the output connection for a defined period of time [3]. The current is defined by a stable and known reference voltage and a precision resistor. The period of current flow is defined by selected number counting of cycles from a crystal controlled clock. The JCI 256 Charge Calibrator provides this calibration capability for quantities of charge from 1-999nC with an accuracy better than 1%. Provision is included to enable the unit itself to be formally calibrated with measurements whose accuracies are traceable to National Standards.

#### **6. RoHS and WEEE Directives**

JCI electrostatic measuring instruments are not required to conform to the RoHS Directive because they come within Category 9 exemption.

To comply with the requirements of the EC WEEE (Waste Electrical & Electronic Equipment) Directive all JCI instruments at the end of their useful life should be returned to JCI so they can be disposed of or recycled in an environmentally appropriate manner. JCI WEEE registration number is: WEE/GA0697TX.

#### **References:**

[1] J. N. Chubb; G. J. Butterworth “*Charge transfer and current flow measurements in electrostatic discharges*” J. Electrostatics 13 1982 p209

[2] J. N. Chubb “*Measurement of charge transfer in electrostatic discharges*” J. Electrostatics 64 2006 p321-325 (JCI Website: [www.jci.co.uk/cache/ProbeStudies.pdf](http://www.jci.co.uk/cache/ProbeStudies.pdf))

[3] J N Chubb “*Methods for the Calibration of Electrostatic Measuring Instruments*” <http://www.jci.co.uk/Calibration/Calibration.pdf>

## 7. SPECIFICATION FEATURES:

<i>Sensitivity range:</i>	20nC & 200nC FSD
<i>Noise and Zero stability</i>	Noise within $\pm 10\text{pC}$ . Zero stable within $\pm 100\text{pC}$
<i>Accuracy and linearity</i>	Within $\pm 5\%$ FSD
<i>Display:</i>	- 3½ digit liquid crystal display of charge transfer directly in nC - LO BATT indication
<i>Alarm:</i>	Pulsing audio signal when charge above user set level
<i>Power supply:</i>	- PP3 replaceable battery - external isolated 12V supply – for example a JCI 142 mains unit
<i>Controls:</i>	- ON/OFF switch selecting OFF, ON 20nC & ON 200nC - Screwdriver set alarm threshold - Zeroing push button in rear cover
<i>Connections:</i>	- BNC input connector on front for charge measurement - Combination Durable Dot/4mm bayonet earth bonding connector - 8w min DIN output connector: <ul style="list-style-type: none"><li>- 2V FSD analogue signal output (5 violet)</li><li>- Analogue earth (2 white)</li><li>- Remote zeroing (3 red)</li><li>- Remote sensitivity change (4 yellow)</li><li>- External power supply inputs (8 +ve brown; 6 –ve blue)</li></ul> - 2.1mm d.c. input for external isolated 12V power supply
<i>Dimensions:</i>	160x66x34mm Weight 300grams
<i>Optional extra:</i>	Shielded discharge probe (JCI 179) for measuring charge transfer in electrostatic and spark discharges



Figure 1: JCI 178 Charge Measurement Unit



Figure 2: JCI 178 with JCI 179 Discharge probe attached