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BRINGING RELIABILITY TO AMPS • VOLTS • OHMS

***BIDDLE*®**
Series 27000

- **Key component of all Biddle partial discharge detection systems**
- **Includes multiple interference control features**
- **Five built-in types of data readout**
- **RS-232C interface for control and data export**

Partial Discharge (Corona) Detector

INTRODUCTION

ASTM defines a partial discharge as a type of localized discharge that results from transient gaseous ionization in an insulation system when the voltage stress exceeds a critical value. The ionization is localized over only a portion of the distance between the electrodes of the system. The resultant partial discharge signals appear as very small magnitude, fast-rise pulses with irregular waveshapes superimposed on the high voltage at the terminals of the test sample. Partial discharges cause deterioration of insulation materials and are a primary cause of insulation failure at moderate and high voltages.

The accepted unit for measurement of partial discharge magnitude is the picocoulomb. The picocoulomb, a unit of charge, is columbs x 10^{-12}. Charge is preferred to voltage as a unit of measure because it is proportional to the destructive energy released at the discharge site. Pulse voltage is undesirable because it is dependent on partial discharge pulse waveshape which is irregular at best.

Partial discharge pulse waveshape is dependent on the location of the discharge site and changes as the pulse propagates through the circuit. The charge, proportional to the number of ions formed at the discharge site, is represented by the area under the partial discharge pulse waveshape. This area remains constant, independent of discharge site location. The energy released is proportional to the product of the number of ions formed and the critical voltage at the discharge site. It is therefore apparent that the response from a properly designed partial discharge detection system must be proportional to the area under the partial discharge pulse.

The Biddle® Partial Discharge Detection System integrates the area under any partial discharge signals detected and displays an output pulse-signal on the oscilloscope which is proportional in height to the integrated area. The ratio of proportionality, in picocoulombs per unit of deflection, is established by using the built-in calibration equipment.

DESCRIPTION

The Biddle Series 27000 Partial Discharge (Corona) Detector is composed of four functional units: the amplifier, display, calibrator and evaluation unit.

Amplifier

The amplifier provides low-noise gain and bandwidth limiting of the partial discharge signals. The gain is continuously variable over four decade ranges and is determined by front-panel controls. The input of the amplifier is galvanically isolated from the source of the signal to minimize grounding problems and to provide protection against common mode transients that often occur during routine testing. Different partial discharge tests may require amplifiers with different bandwidth limiting. In these cases, the detector can be equipped with two amplifiers.

Display

The display circuitry includes partial discharge pulse rectification and brightening circuits, a display time base and an electrostatic CRT display. Pulse rectification is used to enhance the clarity of the display and to make the pulse polarity appear independent of the phase of the test voltage.

The display time base provides a CRT baseline upon which the partial discharge pulses may be superimposed. This baseline is phase-locked to either the test voltage or detector line voltage, providing a phase reference which is essential for ac partial discharge pattern recognition. The detector circuitry will dynamically choose between these two reference signals to see which provides the more suitable phase reference. Front-panel indicators show which phase reference signal is being used.

Three different baselines are available: elliptical, linear and sinusoidal. Each of the baselines is synthesized from phase-locked-loop circuitry so that test-voltage harmonics are completely suppressed and do not appear on the

CRT display. The rotation of the elliptical time base may be altered from the factory-set conventions to suit user requirements.

Two phase-reference markers may be manually activated by pressing a pushbutton switch on the detector front panel. These markers appear as pulses on the display time base. One marker indicates the 0° phase position and the other indicates the 270° phase position of the display time base. They may be used to assist the user in determining the phase angle of partial discharge signals and to remind the user of the elliptical display conventions.

Calibrator

The calibrator provides a precision signal that is used to calibrate the desired readout in units of picocoulombs. The output of the calibrator is continuously variable from 0.1 to 999 pC via a digital control. A digital display with automatic decimal point indicates the actual output level. Calibration can be either direct or indirect (in accordance with IEC 270, ASTM D-1868, method 3 or ASTM D-1868, method 4, respectively).

Evaluation Unit

The evaluation unit is used to measure, process and display several variables pertaining to the partial discharge signal. The variables measured are peak partial discharge in picocoulombs, average partial discharge in microamperes and apparent partial discharge power loss in milliwatts. A front-panel liquid crystal display as well as rear-panel terminal block outputs are used to convey the measurements to the user. These outputs may be used to drive strip chart or X-Y graphic recorders when this capability is required. The evaluation unit also provides the following two important functions:

• Overlimit trip function: The overlimit trip function monitors the detector's peak partial discharge signal and indicates when that signal exceeds the overlimit level via a front-panel control. If the partial discharge exceeds this level, then a trip will occur. A trip is indicated by a front-panel LED and relay contacts which are accessible on a rear-panel terminal block. Since partial discharge is often masked by noise, internal digital filters may be used to minimize false trips, and to vary the sensitivity of the overlimit detector.

• Window-gating function: The window-gating function allows the user to define a window period during which partial discharge is measured. Any interference signals occurring outside of this window will be ignored by the signal measurement and display circuitry. This feature may be used to blank spurious signals that would normally interfere with the precision partial discharge measurement or to isolate signals of interest.

Additional Capabilities

• Partial discharge signal level graphing: Some power cable testing specifications require a graph of the partial discharge level as a function of test voltage. This capability is provided by using the picocoulomb channel analog output for one axis and the Biddle kilovoltmeter analog output for the second axis. The scale of the plot may be calibrated to represent any picocoulomb value.

• The Biddle Series 27000 Partial Discharge Detector with RS-232 port permits creation of a computerized test report. Microsoft® Windows®-based software that will generate a one-page test report is optionally available. Two test report formats are available by menu selection. One format is for routine testing of power cable; the other format is for general-purpose use. The test report includes an X-Y graph of partial discharge level versus test voltage. Menu-driven software permits the operator to enter descriptive information, calibrate the system and initiate data collection.

Upon completion of the test, the operator can view the test data on the monitor to check for compliance with the test requirements before printing or saving.

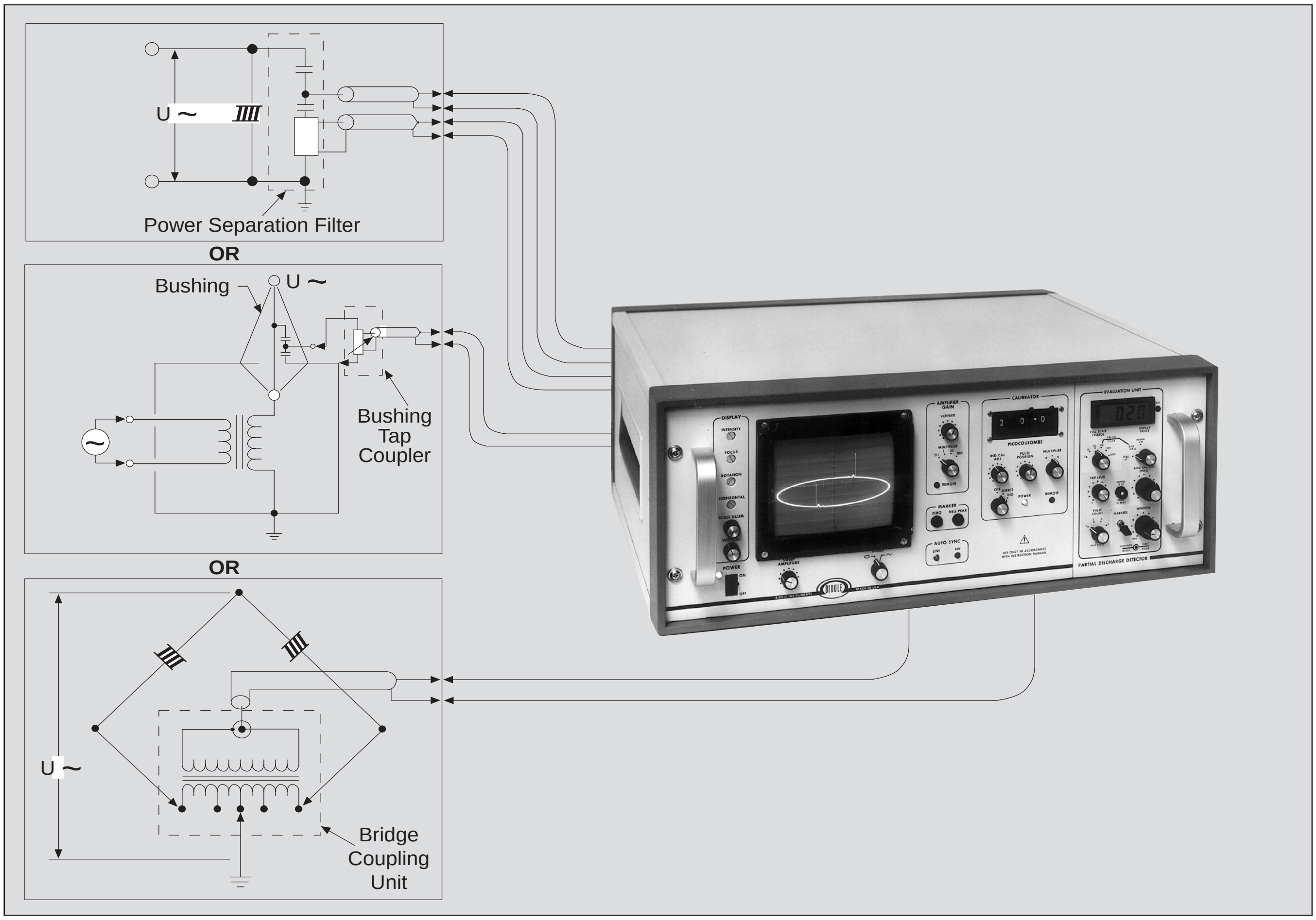
• Interference control: Window gating, overlimit trip functions and digital filtering all serve to minimize or eliminate the effects of unwanted continuous and sporadic signals. Additional shielding and filtering techniques are optionally available to augment this capability and ensure accurate measurement of partial discharge. As an example, common interference from single-phase SCR noise occurs as a pulse on every half-cycle of the test voltage. If the pulse is stationary with respect to the phase of the test voltage, its effects may be completely eliminated by setting the window phase angles so that the pulse is excluded from any measurements. Often, however, the SCR pulse is not stationary. In these cases, the interference is suppressed simply by selecting, via front-panel controls, the criterion of a specified number of pulse repetitions per half-cycle. Suitable settings for various types of interference conditions must be determined on an individual basis.

• Multiple passbands: The Biddle Series 27000 detector includes the capability to operate with different passbands. Some test specifications/applications define the passband needed for the detector system. Sometimes the interference to be expected with a certain application will dictate the pass-band requirement. Biddle provides superior noise rejection by designing specific passband amplifiers with integrated filtering circuits for optimum noise suppression. Three standard passband amplifiers are available: one for cable testing, one for general purpose use and one for transformer testing at test frequencies from 180 to 400 Hertz. Any two of the three can be installed in the Series 27000 detector.

System Requirements

The Biddle Series 27000 detector is the keystone of any partial discharge detection system. A fully operational system requires, in addition to the detector, a power separation filter, a bushing tap coupler or a bridge coupling unit to couple the detector to a test circuit. A properly rated noise-free test voltage source is also required for a complete system.

To graph any of the output channels as a function of test voltage and to operate the apparent power loss readout channel, an optional Biddle kilovoltmeter with recording output is needed.



Schematic diagram showing basic partial discharge detection system configurations available with Series 27000 detector

APPLICATIONS

The keystone of all partial discharge detection systems is the partial discharge detector. This unit provides all of the instrumentation necessary for making partial discharge level measurements when used with appropriate auxiliary components. The Biddle partial discharge detector combines calibration, amplification and oscilloscope display sections in an attractive panel suitable for rack mounting.

Electronic measurement circuitry contained within the Series 27000 detector permits quantifying and expressing partial discharge in objective terms. This decreases the need for reliance on subjective operator interpretations of test results, and allows for consistent, repeatable evaluation and comparison of test data.

FEATURES AND BENEFITS

Five built-in types of data readout provide a wide range of test data formats:

- CRT display
- Three simultaneous channels off analog output suitable for graphic recording of peak partial discharge (picocoulombs), average partial discharge (microamperes) and apparent partial discharge energy or power loss (milliwatts)
- Digital display of any of the above selected data channels
- Programmable partial discharge overlimit trip indicator
- RS-232C interface permits data archiving and test report generation.

A standard computer interface unit provides for archiving data and remotely controlling detector sensitivity and calibration.

Three built-in types of interference control permit testing under adverse local noise conditions:

- Fully adjustable partial discharge inspection windows automatically synchronized to the test voltage
- A partial discharge level detector with programmable response for partial discharge signal magnitude level, signal repetitions per half-cycle and consecutive half-cycles
- A partial discharge measurement circuit that employs digital filtering for minimizing the effects of noise

Automatic synchronization of scope display, calibration signals and window-gating circuits allows full function testing at frequencies from 50 to 500 Hertz.

Switchable passband options increase interference control and expand the range of testing applications.

Selectable, multiformat scope display accommodates user preferences:

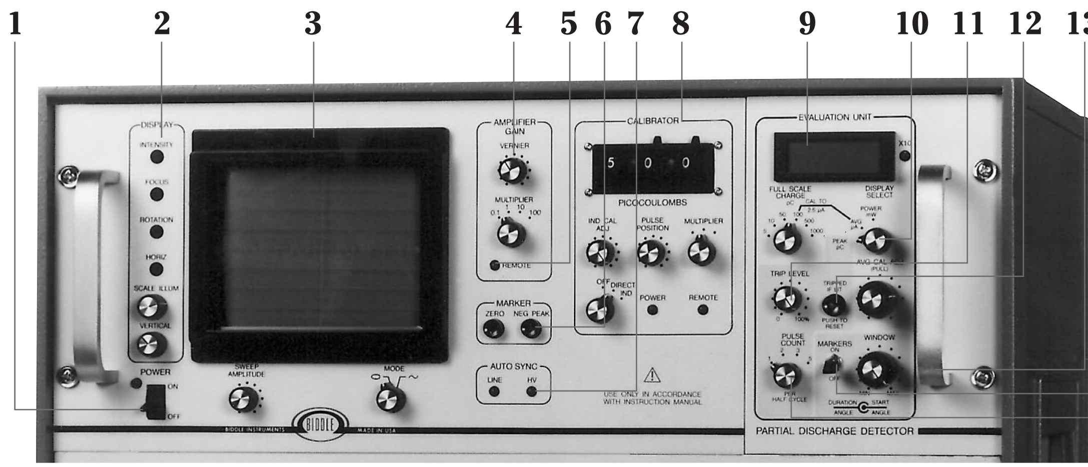
- Available baseline formats: sinusoidal, flat-line and elliptical. Baseline phase verification is provided by 0 and 270° markers.
- Available partial discharge signal formats: unrectified pulses, or positive or negative polarity only

Built-in calibration signal generator simplifies test data quantification.

Detector meets the requirements of IEC 270, IEEE 454-73; ASTM D-1868; IEEE C57.113; ICEA T-24-380; AEIC CS5, CS6, CS7; NEMA WC5, WC7, 502, 540; UL 1072; ICEA S 61-402, S 66-524, S 68-516; and MIL-T-27.

DETECTOR CONTROLS

1. Power switch on/off
2. CRT display adjustments
3. CRT display mode - sine wave or eliptical
4. Amplifier gain controls
5. Remote indication for external control
6. Marker indicates zero or negative peak on CRT display waveform
7. Automatic scope display synchronization indicators
8. Calibrator controls and indicators
9. LCD partial discharge display
10. Partial discharge display channel selector
11. pC trip level adjustment
12. Trip indication lamp
13. Window gating controls
14. Markers on/off for window gating
15. Pulse count per half cycle (for noise control)



SPECIFICATIONS

Input

Input Voltage
120/240 V (+10%, –17.5%), 47 to 500 Hz (selectable at the power input receptacle)

Power Burden: 100 VA max.

Mechanical

Designed for 19-in. (48.3-cm) relay rack mounting

Signal Connectors: BNC (MIL UG625)

Front-Panel Dimensions
7 H x 19 W in.
17.8 H x 48.3 W cm

Weight: 25 lb (11.3 kg)

Environmental

Storage Temperature Range
–40 to +149° F (–40 to +65° C)

Operating Temperature Range
32 to 122° F (0 to 50° C)

Relative Humidity
5 to 95% (noncondensing)

Maximum Altitude: 10,000 ft (3030 m)

CRT Display

3 x 4 in. (8 x 10 cm) with Z-axis modulation

Vertical Deflection Linear Range
0 to 2.7 in. (0 to 7 cm)

Display Synchronization Range
47 to 500 Hz

Display Synchronization Modes
Power line
Test voltage

Automatic Display Synch Switchover (from power line to test voltage)
At approx 5% of rated voltage

Display Sweep Modes
Ellipse
Sine wave
Flat line

Display Sweep Phase Markers
At negative-going zero crossing
At negative voltage peak

Display Pulse Characteristics (available by internal jumper)
Negative polarity only
Positive polarity only
Both polarities (unrectified)

Amplifier

Analog Output: 1-volt output per cm of deflection on CRT to maximum of 8 V

General-Purpose Amplifier Specifications
Bandpass: 40 to 200 kHz at –3 dB
Gain: 86 dB at midband

Cable Test Amplifier Specifications
Bandpass: 20 to 110 kHz at –3 dB
Gain: 92 dB at midband
Pulse Resolution Time: 5 ±1 µs
Negative Superposition: Less than 15%

Transformer Test Amplifier Specifications
Bandpass: 75 to 290 kHz at –3 dB
Gain: 86 dB at midband

Analog Recording Outputs from Evaluation Unit Channels
Peak partial discharge, average partial discharge, apparent partial discharge power loss: 0 to 5 Vdc

Serial Interface: RS-232C, 1200 baud, RTS/CTS handshake

Calibrator

Output Range: 0.1 to 999 pC in three ranges, continuously variable

Output Impedance: 75 Ω

Accuracy
±1.5% full scale on 100-pC range
±4% full scale on 10- and 1000-pC ranges

Modes Provided: Direct in accordance with IEC 270, ASTM D-1868, method 3; indirect, ASTM D-1868, method 4; average channel

Pulse Rise Time
Less than 100 ns (10 to 90%)

Pulse Repetition Rate: Once per half-cycle of the test voltage

Repetition Synchronization Range
47 to 500 Hz

Pulse Phasing
Continuously adjustable

Evaluation Unit

Digital Display
3½ digits, 0.5 in. (13 mm) high, direct reading (of selected channel)

Available Channels
Peak, average, power

Peak Partial Discharge Channel
Span: 1 to 1000 pC
Ranges: 0 to 5/10/50/100/500/1000 pC
Accuracy: ±3% of full scale

Rise Time
Analog Mode (10 to 90%): 80 µs to 2.2 ms, variable
Digital Mode (0 to 100%): Less than 1.0 s

Fall Time
Analog Mode (90 to 10%): 2 s
Digital Mode (100 to 0%): Less than 1.0 s

Average Partial Discharge Channel
Span: 0.01 to 50 µA. in six ranges
Accuracy: ±3% of full scale
Averaging Time Constant: 1.3 s

Apparent Partial Discharge Power Loss
Span: 0.01 to 10,000 mW
Accuracy: ±5% of full scale

Trip Level Detector
Span: 0 to 100% of selected peak partial discharge range

Trip Relay Contacts
1.0 A (max. carrying current)
0.25 A (resistive switching current)

Pulse Count per Half-Cycle Selector
Pulses per Half-Cycle: 1, 2, 3 or 5
Half-Cycle Logic Range: 1 to 8 half-cycles of the test voltage (by internal dip switches)

Display Windows
Synchronization Frequency Range: 47 to 500 Hz
Start Angle Range: 0 to 180°
Duration Angle Range: 5 to 180°

ORDERING INFORMATION

Item	Cat. No.
Series 27000 Partial Discharge (Corona) Detector	6627000
Optional Accessories	
Cable test amplifier	25960
General-purpose amplifier	25960-2
Transformer test amplifier	25960-3
Windows-based software package for test report generation, including fiber-optic RS-232C interconnection cable, 486-class, IBM-compatible computer, 3.5-in., high-density floppy drive, VGA color monitor and compatible dot matrix printer	33730

AVO INTERNATIONAL

UNITED STATES
4651 S. WESTMORELAND ROAD
DALLAS, TX 75237-1017 USA
PHONE: (214) 333-3201
FAX: (214) 333-3533
EXPORT FAX: (214) 337-3038

510 TOWNSHIP LINE ROAD
BLUE BELL, PA 19422 USA
PHONE: (800) 723-2861
FAX: (215) 643-2670

CANADA
180 MIDDLEFIELD ROAD
SCARBOROUGH, ON M1S 4M6
CANADA
PHONE: (416) 298-6770
FAX: (416) 298-7214