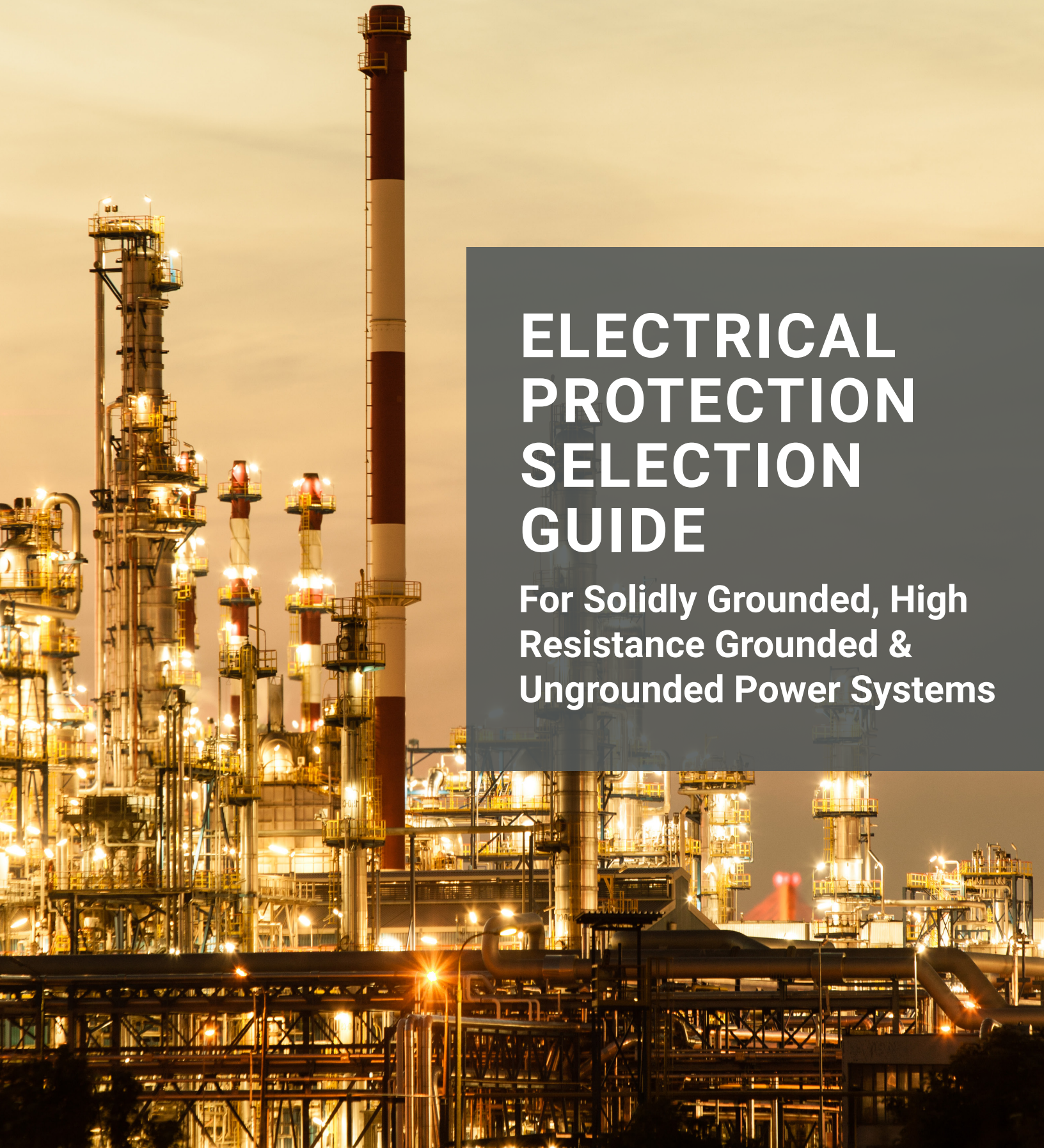
BENDER®

The Power in Electrical Safety



ELECTRICAL PROTECTION SELECTION GUIDE

For Solidly Grounded, High Resistance Grounded & Ungrounded Power Systems

SELECTING THE GROUNDING SCHEME FOR COMMERCIAL AND INDUSTRIAL POWER SYSTEMS

A power system's grounding scheme affects availability, reliability and safety.

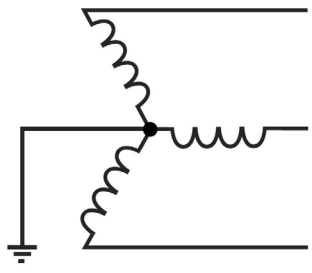
Often, the addition of ground-fault detection systems, and sometimes conversion to a different system type, can enhance these aspects of any power system, usually with a significant return on the investment.

Bender offers cost-effective grounding and ground-fault detection systems with expertise across the range of commercial and industrial installations. Discover more about the different types of electrical power systems available and the advantages and disadvantages of each:

1. Power System Grounding Methods

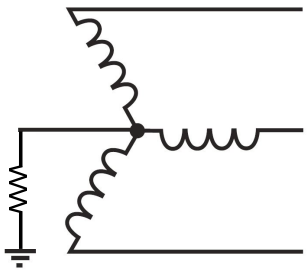
A. Solidly Grounded

In solidly grounded systems, the neutral point of a power system is connected to earth with a low-impedance conductor, allowing high ground-fault current levels.



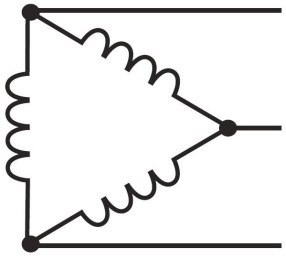
B. High Resistance Grounded (HRG)

The neutral point of an HRG system is grounded through a resistor that limits ground-fault current and controls ground-fault voltage on driven equipment.



C. Ungrounded

In ungrounded systems, there is no purposeful connection to ground. In the event of a ground fault, only a small leakage current, essentially caused by system leakage capacitances, can flow.



2. What are the advantages of each system grounding method?

A. Solidly Grounded

- Faults are readily detected and isolated quickly by circuit protective devices.
- Easily identify and selectively trip the faulted circuit; May maintain continuity of service for remaining circuits.
- No possibility of transient overvoltages[1], which can damage critical equipment.

B. High Resistance Grounded (HRG)

- Limits the ground fault current to a low level—no additional equipment damage.
- Easily identify the faulted circuit; continue to operate or selectively trip faulted load.
- No possibility of transient overvoltages which can damage critical equipment.
- There is no Arc Flash[2] risk for a phase-to-ground fault.
- Allows for planned maintenance, repair and operations capability due to an electrical ground-fault.

C. Ungrounded

- Very low level of current flow for phase-to-ground faults.
- There is no Arc Flash risk for a phase-to-ground fault.
- No ground-fault trips; Maintains continuity of service for entire electrical system.
- Lower probability of phase-to-ground faults escalating to phase-to-phase or 3-phase fault.
- Allows for planned maintenance, repair and operations capability due to an electrical ground-fault.

[1] Transient overvoltage: while rare, an intermittent ground fault can cause all phases of a power system to elevate, up to 10 times system voltage, above ground potential. Equipment damage results.

[2] Arc Flash: explosive release of energy when current arcs through air between conductors. Catastrophic equipment damage, plant burn-down, and personnel injury are possible.

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[1] *IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (IEEE Buff Book), 2001. pp.8.2.5, 8.3.3.*

[2] *IEEE Recommended Practice for the Electric Power Distribution for Industrial Plants (IEEE Red Book), 1993. pp.5.1, 5.2.2.*

3. What are the disadvantages of each system grounding method?

A. Solidly Grounded

- Severe risk for Arc Flash and high values of fault current.
- Potential for severe and expensive equipment damage.
- Low-level early-stage ground faults are often not detected.
- May trip entire facility instead of contributing ground-fault circuit.
- Unplanned interruption of production lines or critical processes and extended downtime.

B. High Resistance Grounded (HRG)

- High frequencies or harmonics can appear as nuisance alarms on monitoring systems.
- Ground faults may be initially left on the system for an extended period of time.
- Not suitable for single-phase loads (eg: lighting).

C. Ungrounded

- Transient overvoltages are uncontrolled.
- Cost of system maintenance can be higher due to downtime and labor which are involved with physically identifying the contributing fault.

4. How to mitigate the disadvantages or risks of each type of system.

A. Solidly Grounded

1. Severe risk for Arc Flash Hazards and high values of fault current:

a. Convert to High Resistance Grounded System using Bender HRG Series and Neutral Grounding Resistor Monitoring (NGRM) devices.

i. Ability to limit ground-fault current to 5A or less.

ii. No Arc Flash Hazard for phase-to-ground fault.

2. Potential for severe and unrepairable equipment damage and low-level early-stage ground faults are often not detected:

a. Implement Residual Current Monitoring (RCM) devices.

i. Allows for selective coordination, low-level ground-fault detection and individual trip levels to be established.

3. Unplanned interruption of production process/ downtime:

a. Implement RCM Devices.

i. Allows for selective coordination, low-level ground-fault detection and individual trip levels to be established.

ii. Allows for immediate identification of the circuit which is contributing to the ground fault and lowers the cost of downtime.

b. Convert to HRG.

B. High Resistance Grounded (HRG)

1. High frequencies or harmonics can appear as nuisance alarms:

a. Implement Bender Neutral Grounding Resistor Monitor (NGRM) devices to monitor the continuity, open and short conditions with harmonic filtering of the electrical system.

2. Ground faults may be left on system for extended period of time:

a. Implement NGRM devices to monitor the continuity, open and short conditions with harmonic filtering of the electrical system.

C. Ungrounded

1. Transient overvoltages are uncontrolled:

a. Convert to High Resistance Grounded System using Bender HRG Series and NGRM Devices.

2. Cost of system maintenance can be higher due to downtime and labor which are involved with physically identifying the contributing fault:

a. Implement Bender Insulation Monitoring Device (IMD) and Earth Detection System (EDS) to identify and locate ground faults in real-time.

	Basic	Standard
A. Solidly Grounded	**RCM420** *AC Ground-Fault Monitor*  ■ Ground-fault pick up levels are adjustable from 10 mA to 10 A (AC Systems Only) ■ Two Form-C (SPDT) relay outputs are separately configurable to trigger on a pre-warning or main alarm ■ Three separately adjustable time delays are available – pickup delay, startup delay and delay on reset **LifeGuard®**  ■ Ground-fault interruption in single- or three-phase AC systems up to 600V and 100A ■ Suitable for systems with mixed AC/DC components, such as Variable Frequency Drives (VFD) ■ Enclosure options include NEMA 4X polycarbonate, NEMA 4X stainless steel, and non-enclosed ■ Available in a 6-mA fixed trip level with UL 943 inverse time characteristic	**RCMA420** *AC/DC Ground-Fault Monitor*  ■ Ground-fault pickup levels are adjustable from 10 mA to 500 mA (AC/DC Systems) ■ Two Form-C (SPDT) relay outputs are separately configurable to trigger on a pre-warning or main alarm ■ Three separately adjustable time delays are available – pickup delay, startup delay and delay on reset
B. High Resistance Grounded (HRG)	**RC48N** *Ground Fault & NGR Monitor*  ■ Adjustable ground-fault trip level & time delay ■ Monitors NGR continuity on systems up to 5 kV using a CD1000 or CD5000 coupling device ■ Two Form-C (SPDT) relay outputs are separately configurable to trigger on a pre-warning or main alarm ■ Switchable wide-band or band-pass filter for 50/60 Hz **RC48C** *Ground Fault & Ground Check Monitor*  ■ Adjustable ground-fault trip level and time delay ■ Monitor integrity of ground conductor with E6-series termination module ■ Two Form-C (SPDT) relay outputs are separately configurable to trigger on a pre-warning or main alarm ■ Trailing cable monitor used for mobile or moveable loads **Series 1** *HRG System*  ■ Ground-fault detection ■ Pulsing ■ Analog metering ■ Compact wall mount design	**NGRM500** *NGR Monitor*  ■ Open & shorted NGR detection ■ Monitors integrity of NGR using active and passive methods – works when the system is online or offline ■ Integrated web server, Modbus TCP/IP, and Modbus RTU ■ AC/DC ground-fault protection/detection to properly monitor non-linear loads ■ Preventative maintenance – sensitive ground-fault pickup levels allow early warning of insulation degradation ■ Simplified design - Controls pulsing contractor in pulsing HRG systems **Series 2** *HRG System*  ■ Up to 60 feeders ■ AC/DC ground-fault detection ■ Pulsing ■ Resistor monitoring ■ Harmonic filtering
C. Ungrounded	**IR420** *Insulation Monitor*  ■ Insulation monitoring for ungrounded circuits from 0-300 VAC ■ Two Form-C (SPDT) relay outputs are separately configurable to trigger on a pre-warning or main alarm ■ AC control circuits in the industrial sector, mechanical engineering, power plants, elevators and automation systems **IR425** *Insulation Monitor*  ■ Insulation monitoring for ungrounded circuits from 0-300 VAC/DC ■ Two Form-C (SPDT) relay outputs are separately configurable to trigger on a pre-warning or main alarm ■ AC/DC control circuits in the industrial sector, mechanical engineering, power plants, elevators and automation systems	**iso685-D** *Insulation Monitor*  ■ Detects AC and DC, symmetrical and asymmetrical ground faults in ungrounded systems ■ Ideal for systems with variable frequency drives ■ Adjustable alarm values up to 10 MΩ ■ Modbus/TCP communication included

Advanced

RCMS490
12-Channel AC/DC Ground-Fault Monitor

- Ground-fault pick up levels are adjustable from 6 mA to 20 A (AC/DC Systems)
- Ground-fault monitoring for up to twelve separate systems or channels
- The on-board LCD display shows a detailed system overview, including a chart showing measured ground-fault current in real-time, individual alarm messages for each channel, and an easy-to-use menu for adjusting settings

NGRM700
NGR Monitor

- All NGRM500 features in a different form factor plus:
- Detachable HMI
- Phase to-phase and phase-to-ground voltage monitoring
- Designed for operation in extreme environments including an altitude rating of 5,000 meters above sea-level
- Program & display information without opening doors using door-mounted HMI
- Network communications

Series 3
Second Ground-Fault Protection

- Up to 120 feeders
- Second ground-fault protection
- Touch screen HMI

iso685-D-P
Insulation Monitor

- Detects AC and DC, symmetrical and asymmetrical ground faults in ungrounded systems
- Ideal for systems with variable frequency drives
- Adjustable alarm values up to 10 MΩ
- Modbus/TCP communication included
- Earth Detection System Pulse

EDS440
Ground-Fault Locator

- Use in combination with a Bender ground-fault detector to locate the fault on up to 12 channels per module
- Automate fault location while the system remains online, greatly reducing time required to find ground faults
- Get fast notification of located faults over Ethernet or Modbus/TCP

Modular/ Portable

RCMB300 SERIES
AC/DC Ground-Fault Monitor w/CT

- Ground-fault pick up levels are adjustable from 5 mA to 20 A (AC/DC Systems)
- Modular design with current transformer between 20 mm to 210 mm in diameter
- Frequency range from DC to 100 kHz (Ideal for Inverters and Energy Storage Systems)
- RS-485 interface with Modbus RTU

EDS3090 Series
Portable Ground-Fault Locator

- Quickly locate and identify ground faults with portable equipment
- Hand-held EDS3090 fault locater can be used in combination with permanently installed Bender ground-fault monitoring equipment
- Two sizes of split-core clamps included
- Ideal for contract service technicians and facilities with preventative maintenance programs

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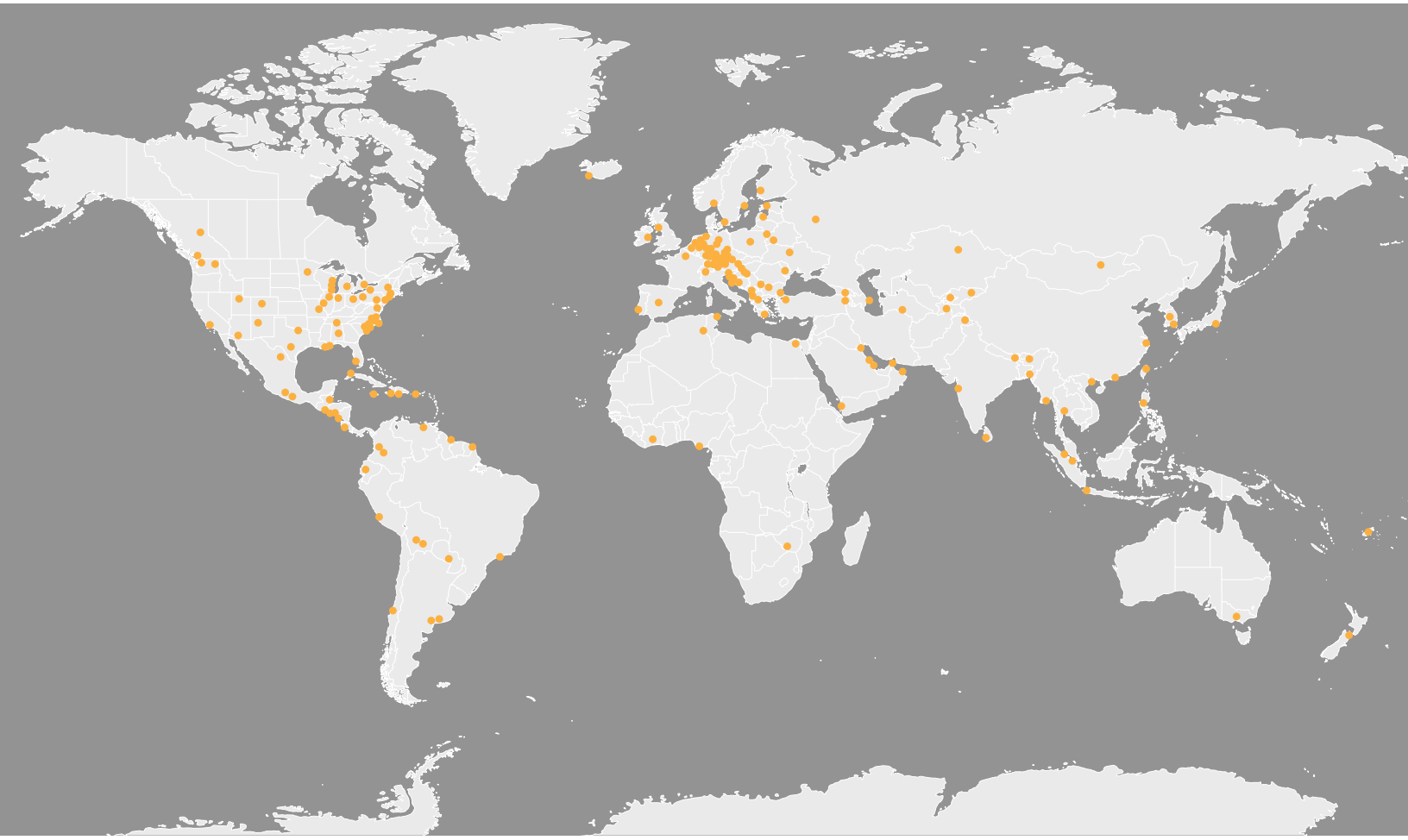
Bender is located in 70 countries around the world!



USA • Exton, PA
800.356.4266 / 610.383.9200 • info@benderinc.com
www.benderinc.com

Canada • Missisauga, ON
800.243.2438 / 905.602.9990 • info@bender-ca.com
www.bender-ca.com

Mexico • Ciudad de Mexico
+972 517-7147 / + (55) 4955 1198 • info@bender.com.mx
www.bender.com.mx

South America, Central America, Caribbean
+1 (484) 288-7434 • info@bender-latinamerica.com
www.bender-latinamerica.com

Chile • Santiago de Chile
+56 2.2933.4211 • info@bender-cl.com
www.bender-cl.com