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Pulsed EMI
CATALOG



Model 424 Series Surge Generators, Groups and Options

Model 424 Main Frame

Surge Generator Mainframe with broad capabilities for surge generation and monitoring. Accepts over 35 standard and custom Programmer Networks. Each network supplies different output waveforms for a variety of surge test applications.

The Model 424 provides a wide variety of standard surge test waves for protective components such as gas tubes, silicon avalanche and crowbar protectors, MOVs, resistors, capacitors and so on. Specific Programmer Networks also furnish standard surge test waves specified by ANSI, IEEE, FCC, UL, IEC and other organizations, for surge testing both circuits and equipment. These include the necessary ability to surge operating equipment connected to active power lines.

Model 424 Mainframe Options are available to increase its basic energy storage from 80 to 560 joules, with peak output voltages up to 6 kV and peak output currents as high as 2000A. Standard features include digital readouts for peak surge current and for peak surge voltage, measured at the surge load (i.e., using a Kelvin, four-wire system). Other options provide remote operation with BCD readouts for delivered peak surge current and voltage, higher surge repetition rates, measurement of low surge currents, and a host of other features. The most recent of these include capability for true three-terminal surging of protectors and equipment, for telecommunication surging to meet LSSGR protocols.

Factory Options

- C-424* Wiring, connectors and test required in the Model 424 for factory or field addition of Model 210 or Models 210 and 211.
- HQ-424* High rep-rate surging, (typically 3 times normal rate) for all Programmer Networks, including 10x1000 waves, except the PN 291, which is already 4 x normal rate. Requires option HQ-PNXXX.
- HQ-PNXXX* Modification required for all Programmer Networks used with HQ-424 option. (Not relevant to PN 291.)
- I-424* Provides user selectable current ranges, including 10A range for certain programmer networks.
- K-424 Rear, key-operated interlock switch (inhibits entire Model 424/Series 1000 operation).
- LS-424* Modification and test of Model 424 required for addition of PN281LSC or PN282LS.
- P-424* ** Provides for remote operation of the Model 424 mainframe, plus BCD outputs for peak surge current and peak delivered surge voltage.
- R-424 Rack-mount handles for Model 424.
- S-424* Floating, pre-trigger synch output††.
- T-424** Wiring and front output connectors required in the Model 424 for use with three-terminal-output Programmer Networks such as the PN292, PN293, PN294 and PN296. Also compatible with all two-terminal networks except the PN249.

NOTE: Option T-424 coordinates with 450HT or 480T output test fixtures, even when used with two-terminal networks, and is not compatible with 450, 450H or 480 fixtures.

- L-424††† Modifications to Model 424 required for use with PN246L.

* If retrofit is ordered more than one year after initial shipment, must include Model 424 factory recalibration.

** Model 424's with serial numbers prior to 8807001 require retrofit and internal modifications in order to provide the BCD outputs for peak surge current; consult factory.

† An additional one-time charge is required for Model 424s with serial numbers prior to 8806001; consult factory.

†† Primarily for oscilloscope display of surges superimposed on ac power lines, with PN281 and PN282 Programmer Networks. Internal scope synch is usually preferable with other waves, particularly those from the PN246, PN284 and PN286 that can in fact be faster than the synch pulse.

††† Must include Model 424 factory recalibration.



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Model 424 Series Surge Generators, Groups and Options

Standard 424 Series Equipment Group to meet LSSGR*

Equipment Group	Equipment Performance				Equipment Supplied
Model Group 424/LSSGR*	True three-terminal, high-energy surging for protectors and equipment. Separate, resistor-isolated outputs insure that arrester operation or flashover on one line will not eliminate availability of the surge on the other. Thus, tip and ring inputs will each be fully stressed and realistically tested for protection. (One Programmer Network, the PN295, is only two-terminal. It is, nevertheless, required for LSSGR.)				Model 424 Opt. C-424 Opt. T-424 Model 210 Model 211 PN 292 PN 293 PN 294 PN 295
	Programmer Network	Peak V	Short-circuit current wave	Peak I per side	
	PN 292	600V	$\leq 10 \times \geq 1000$	100 A	
	PN 293	1000 V	$\leq 10 \times \geq 360$	100 A	
	PN 294	1000 V	$\leq 10 \times \geq 1000$	100 A	
	PN 295†	1000 V	$\leq 10 \times \geq 2500$	200 A	
	† two-terminal				
Model Group 424/ LSSGR-PLUS Adds:	Additional options that are highly useful although not mandatory for LSSGR testing:				Opt. S-424 Opt. P-424 Opt. HQ-424 Opt. HQ-292, 293, 294, 295 Model 450 HT Model 480 T Model PK1001D

* LSSGR also requires additional, Model 587 or Model 711 equipment; see appropriate listings in section on Model 587-PLUS Plug-In Surge Networks, and 711 Series Model Groups and 711 Series Surge Networks.

Note that for LSSGR waveforms, front time for both voltage and current is defined as $1.25 \times$ risetime (or $1.25 \times$ time from 10% to 90% of peak).



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424 Series Programmer Networks

Required Units
and Options

Model 424 Programmer Networks

		1-424†
PN241	10 × 1000, max current 60A	
PN242	8 × 20, max current 500A.	
PN242H	50 ns × 20 μs current; max 10A, at a voltage setting of 1 kV. Voltage ramp speed is ~ 10 kV/μs, or takes ~ 50 ns to reach 500V. 10A can be delivered into clamping protectors up to 500V by setting voltage as high as 1.5 kV (giving proportionately higher voltage ramp speed).	
PN243	1.2 × 50, max current 500A.	
PN246	100 V/μsec - 10kV/μsec, 1kV linear.	
PN246L	Selectable open-circuit voltage ramps of 2V/μs to 525V, and .02V/μs to 400V. Maximum peak gas-tube (DUT) current is 50A.	L-424
PN247	8 × 20 current, max 2000A (Use Model 450H if test fixture is required). Not usable with Model 450)	PN242*
PN248	FCC Docket 19528 Part 68 surges: $< 10 \times > 160 \mu s$, 0-1500 V, 200 A max $< 10 \times > 560 \mu s$, 0-800 V, 100 A max	
PN249	4 × 200, max current 1500A (Use Model 450H if test fixture is required). Not usable with Model 450, or with option T-424)	210
PN250	10 × 1000, max current 250A	210, PN241*
PN250D	10 × 1000 voltage and current into a 15 ohm load (7.5 × 1300 open-circuit, 15 × 650 short-circuit); 200A short-circuit current	210, PN241*, 250*, or 250D*
PN251	10 × 1000 current, max 500A	
PN252	10** × 1000 and 100** × 1000 open-circuit voltage, 0-1kV; 45A max short-circuit current.	
PN252A	10** × 1000 and 100** × 1000 open-circuit voltage, 0-1.5kV; 45A max short-circuit current.	
PN253	100kV/μsec, durations 20 to 1000 μsec.	
PN255	1 × 40 voltage; 1.5kV; current to 500A.	
PN281	5μs rise, 100kHz IEEE 587/UL ring wave with built-in, normal mode (line-to-line) ac power-line surge coupler/filter for 115/230V, 50-60 Hz. Up to 10A continuous, 15A intermittent duty.	
PN281LSC	Same as PN281, plus surge positioning at continuously selectable ac line phase angle, 0-360 degrees; via Option LS-424. Also includes ac line coupling mode selection — normal and all three common modes	LS-424, S-424†
	Option LSC-PN281:	LS-424, S-424†
	Retrofit PN281 to become PN281LSC	LS-424, S-424†
	Option C-PN281LS:	
	Retrofit PN281LS to become PN281LSC	
PN282	$< 2 \times > 10$, FCC, with built-in, normal mode (line-to-line) ac power line surge coupler/filter for 115/230V, 50-60 Hz. Up to 10A continuous, 15A intermittent duty.	
PN282LS	Same as PN282, plus surge positioning at continuously selectable ac line phase angle, 0-360 degrees; via Option LS-424	LS-424, S-424†
	Option LS-PN282:	LS-424, S-424†
	Retrofit PN282 to become PN282LS	

NOTE: Performance of all Programmer Networks is specified with Model 485 or Model 486 terminating network in use, or else with a Model 450, 450H, or 450HT test fixture. For use in any other configuration, consult factory.

* Highly recommended if lower current surging with the same waveform is anticipated.

** Rise time, not front time.

† Not mandatory but highly recommended.



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424 Series Programmer Networks and Accessories

		Required Units and Options
Model 424 Programmer Networks (continued)		
PN284	EMP — damped 1 MHz cosine, 2kV peak, ~3ns rise.	
PN286	500 V/ μ sec · 10 kV/ μ sec, 3 kV linear, 100 V/ μ s 2.0 kV linear.	
PN291	10 × 1000 currents, 1A to 300A. Already includes 4 × normal surge rate capability, so Options HQ-424 and HQ-PNXXX not applicable.	210, 211, T-424
PN292 (LSSGR)**	Two and three-terminal outputs, 600 V peak, $\leq 10 \times \geq 1000$ SCI* waveform, 100A per side. (Compatible with Option T-424, 450HT and 480T output fixtures; not compatible without Option T-424, or with 450, 450H or 480 output fixtures.)	210, 211, T-424
PN293 (LSSGR)**	Two and three-terminal outputs, 1kV peak, $\leq 10 \times \geq 360$ SCI* waveform, 100A per side. (Coordinates with Option T-424, 450HT and 480T output fixtures; not compatible without Option T-424, or with 450, 450H or 480 output fixtures.)	210, T-424
PN294 (LSSGR)**	Two and three-terminal outputs, 1kV peak, $\leq 10 \times \geq 1000$ SCI* waveform, 100A per side. (Coordinates with Option T-424, 450HT and 480T output fixtures; not compatible without Option T-424, or with 450, 450H or 480 output fixtures.)	210, 211, T-424
PN295 (LSSGR)**	Two-terminal output, 1kV peak, $\leq 10 \times \geq 2500$ SCI* waveform, 200A	210, 211
PN296	Two and three-terminal outputs, for two- and three- terminal surging to CCITT Rec. K20, KY, KW. 1kV peak, 10 × 700 at 25A peak per output; 1.5 kV peak, 10 × 700 at 37.5A peak per output. Fully compatible with Model 424 without Option T, and with 450, 450H, 480 output fixtures for two-terminal outputs. Fully compatible with Model 424 with Option T, and with 450HT, 480T output fixtures for three-terminal outputs	T-424 for 3-terminal outputs
Model 424 Accessories		
210	Energy Storage Unit	C-424
	Option R-210, Rack-Mount Handles for Model 210.	
211	Energy Storage Unit	210
	Option R-211, Rack-Mount Handles for Model 211.	
450	Test Fixture, to 500A surge current (not for PN247, PN249 or PN292-294) Option SD-450, semi-dark operation.	
450H	Test Fixture, to 3000A surge current (including for PN247, PN249). Option SD-450H, semi-dark operation.	
450HT	Test Fixture for three terminal applications: for use with PN292, PN293, PN294, and for PN296 when used in a Model 424 equipped with Option T-424. Also can be used for two terminal applications with a Model 424 equipped with Option T-424.	T-424
	Option SD-450HT, semi-dark operation.	
480	Output Connector/Cable Assembly (not for PN292, PN293, PN294 or PN296).	
480T	Output Connector/Cable Assembly: for use with three terminal PN292, PN293, PN294, and for PN296 when used in a Model 424 equipped with Option T-424. Also can be used for two terminal applications with a Model 424 equipped with Option T-424.	T-424
485†	Output Terminator for waveshape control at Model 424 output terminals. (Not necessary with Test Fixtures Model 450, 450H or 450HT.) (Included at no charge with original shipment of Model 424 Mainframe).	
486†	Alternate Output Terminator for waveshape control at Model 424 output terminals. (Not necessary with Test Fixtures Models 450, 450H or 450HT.) (Included at no charge with original shipment of Model 424 Mainframe).	

NOTE: Performance of all Programmer Networks is specified with Model 485 or Model 486 terminating network in use, or else with a Model 450, 450H, or 450HT test fixture. For use in any other configuration, consult factory.

* SCI = short-circuit current.

** Note that for LSSGR waveforms front time for both voltage and current is defined as 1.25 × risetime (or 1.25 × time from 10% to 90% of peak).

† Only 485 or 486 required unless Model 424 has Option T-424, in which case one should be used on each output. Both are supplied as standard equipment with all Model 424 mainframes. 486 has rear output terminals; 485 does not.



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424 Series Accessories

Required Units
and Options

Model 424 Accessories (continued)

- 488, 488N,
488S Output Termination Assemblies, for use with all versions of PN281, PN282, PN284, PN286 and PN291. (Included at no charge with original shipment.) Specify Programmer Network requirements when ordering, in order to determine the correct 488 Model.
- 488T Output Termination Assembly for use with a Model 424 with Option T, operating with any version of the PN281, PN282, PN284, PN286 and PN291. (Included at no charge with original shipment of Programmer Network if accompanying a Model 424 with Option T; or when adding Option T-424 to 424 mainframes incorporating any of these Programmer Networks.) Specify Programmer Network requirements when ordering.
- PK1001D Differential, 6kV, 10 ns risetime surge and transient probe (10 K input impedance each input).
- PK1002D Same as PK1001D, except 10kV, and risetime < 15 ns.
- C-424KPR Option C Keeper. Permits using the Model 424 equipped with Model 210 (or Models 210 and 211) without having the Model 210 connected, for those Programmer Networks that don't require it.

NOTE: not needed for normal operation. The Programmer Networks that don't need the Model 210 ignore it even if it is connected. The Option C Keeper is merely a convenience to permit operating the Model 424 by itself when high-energy programmers aren't needed. It satisfies the Model 424 interlock requirements via a dummy high-voltage connector with suitable jumpers.

Computer Interfaces

- 145 Provides interface to IEEE 488 parallel bus for Model 424 charge/pulse control functions, surge polarity, and digital readout for peak V and I.* Includes cable terminated for connections to rear connector of Model 424 equipped with Option P-424. Also includes a 'C' software subroutine library for control of Model 424 IEEE 488 bus operation (see note). Requires a computer running MS-DOS 3.3 or greater, with a Capital Equipment Corp. PC < > 488 interface card. (Computer and CEC card user-supplied.)
- NOTE: 'C' library does not include routines for printing, saving of data to file or control of any other peripheral devices.

P-424

Model 424 Surge Standards†

- 491†† 7V Surge Standard, calibrated for PN241 (15A mode), PN242 (20A mode) and PN246 (500V/μs).
- 492†† 100V Surge Standard, calibrated for PN241 (15A mode), PN242 (20A mode) and PN246 (500V/μs).
- 493†† 800V Surge Standard, calibrated for PN241 (15A mode), PN242 (20A mode) and PN246 (500V/μs).
- 494 Gas Tube Surge Standard, calibrated for use with PN246 (10kV/μs).

Factory Recalibration, Certification, Test Data and Extended Warranties See Service Section

* I readouts available only for units with upgraded V, I and Program/Readout boards; this includes all new units shipped from 1989 on, and some 1988 units. Consult factory for details.

† All voltages are nominal. Actual calibration voltage may vary from nominal, depending on type of device supplied in each standard.

†† For Model 424 calibration using Surge Standards, it is highly recommended that all three basic units — the Models 491, 492 and 493 — be procured as a group.