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## Standards and Approvals

## UL and CSA file numbers and guide card numbers

Most control equipment listed in this catalog is designed, manufactured and tested in accordance with the relevant UL and CSA standards as listed on pages 19/2 and 19/3.

Equipment	SEC	CSA		UL-listed		UL-recognized			
		® Guide No.	File No.	® Guide No.	c® File No.	® Guide No.	c® File No.	® File No.	
3RV motor starter protectors	1	Class 3211 05	LR 12730	NLRV	NLRV7	E 47705	-	-	-
3RV as self-protected controller (Type E)	1	Class 3211 08	LR 12730	NKJH	NKJH7	E 156943	-	-	-
3RV17, 18, 27 & 28 as circuit breakers	1	Class 1432 01	LR 12730	DIVQ	DIVQ7	E 235044	-	-	-
3RA13 & 23 reversing contactors	2	Class 3211 04	LR 12730	NLDX	NLDX7	E 31519	NLDX2	NLDX8	E 31519
3RH control relays	2	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RT contactors	2	Class 3211 04	LR 12730	NLDX	NLDX7	E 31519	NLDX2	NLDX8	E 31519
3TB contactors	2	Class 3211 04	LR 12730	NLDX	NLDX7	E 31519	NLDX2	-	E 31519
3TC4 DC Contactors	2	-	-	NLDX	NLDX7	E 31519	-	-	-
3TC5 DC Contactors	2	-	-	NLDX	-	E 31519	-	-	-
3TF6 contactors	2	Class 3211 04	LR 12730	NLDX	NLDX7	E 31519	NLDX2	-	E 31519
3TX7 surge suppressors	2	Class 3211 03	LR 12730	-	-	-	NKCR2	NKCR8	E 31519
3RB20 / 21 solid-state overload relay	3	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RB22, 23 & 24 solid-state overload relay	3	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RB30 / 31 solid-state overload relay	3	-	-	NKCR	NKCR7	E 44653	-	-	-
3RU21 thermal overload relay	3	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3UF7 SIMOCODE intelligent overload relay	3	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RA*1 & *2 combination starters	4	Class 3211 05	LR12730	NLDX	NLDX7	E 31519	-	-	-
3RA6 compact starter as manual motor controller	4	Class 3211 05	LR 12730	NLRV	NLRV7	E 47705	-	-	-
3RA6 compact starter as self protected controller (Type E)	4	Class 3211 08	LR 12730	NKJH	NKJH7	E 156943	-	-	-
8US1 busbar components	5	-	-	NMTR	NMTR7	E328403	-	-	-
8US1 busbar adapter shoes	5	<sup>2)</sup>	<sup>2)</sup>	-	-	-	NMTR2	NMTR8	E 328403
FB busbar adapter system	5	<sup>2)</sup>	<sup>2)</sup>	-	-	-	NMTR2	NMTR8	E 160776
3RM1 hybrid motor starter	6	-	-	NMFT	NMFT7	E 143112	-	-	-
3RW30 Soft starters	7	Class 3211 06	LR 12730	NMFT	NMFT7	E 143112	-	-	-
3RW30/31 Soft starters	7	Class 3211 06	LR 12730	NMFT	NMFT7	E 143112	-	-	-
3RW40/44 Soft starters	7	Class 3211 06	-	NMFT	NMFT7	E 143112	-	-	-
73 enclosed soft starters	7	-	-	NJAV	NJAV7	E 43399	-	-	-
74 combination soft starters	7	-	-	NJAV	NJAV7	E 43399	-	-	-
3RF20, 21 & 22	8	-	-	NMFT	NMFT7	E 143112	NRNT2	NRNT8	E44653
3RF23 & 24	8	-	-	NRNT	NRNT7	E44653	-	-	-
3RF24 & 34 solid-state contactors	8	Class 3211 07	LR12730	NMFT	-	E 143112	-	-	-
11 manual starters	9	Class 3211	LR 6535	NLVR	NLRV7	E 10590	-	-	-
14, 22, 30, 40, 43 starters & contactors	9	Class 3211	LR 6535	NLDX	NLDX7	E 14900	-	-	-
17, 18, 25, 26, 32 combination starters	9	Class 3211	LR 6535	NKJH	NKJH7	E 185287	-	-	-
36, 37 reduced voltage starters	9	Class 3211	LR 6535	NLDX	NLDX7	E 14900	-	-	-
83, 84, 85, 87, 88 pump control panels	9	Class 3211	LR 6535	NKJH	NKJH7	E 185287	-	-	-
48, 958 overload relays ESP200	9	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
49 field kits	9	Class 3211	ELR 535	NLDX	-	E 14900	NLDX2	-	E 14900
CLM lighting contactors	9	-	-	NRNT	NRNT7	E 27683	-	-	-
LC lighting contactors - open	9	-	-	NLDX	NLDX7	E 14900	-	-	-
LC lighting contactors - enclosed	9	-	-	NRNT	NRNT7	E 27683	-	-	-
LEN00B, C, D, E lighting - open	9	-	-	NLDX	-	E 31519	-	-	-
LEN00F, G, H, lighting - open	9	-	-	NRNT	NRNT7	E 27683	-	-	-
LE lighting contactors - enclosed	9	-	-	NRNT	NRNT7	E 27683	-	-	-
MMS manual switches	9	-	-	NLRV	-	E10590	NLRV2	-	E 10590
SMF manual starters	9	-	-	NLRV	-	E10590	NLRV2	-	E 10590
3SB2 16mm pushbuttons and indicator lights	10	Class 3211 03	LR 12730	-	-	-	NKCR2	-	E 44653
3SU1 22mm pushbuttons and indicator lights	10	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
50 standard duty pilot devices	10	Class 3211	LR 6535	NKCR	NKCR7	E 22655	NKCR2	NKCR8	E 22655
51 hazardous location pilot devices	10	Class 3218	LR 23889	NOIV	NOIV7	E 39935	-	-	-
52 30 mm pilot devices	10	Class 3211	LR 6535	NKCR	NKCR7	E 22655	-	-	-
8WD signal columns	-	-	-	NMTR	NMTR7	E 148698	-	-	-
3RN1 thermistor motor protection	11	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RP2 electronic time-delay relay	11	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RQ3 coupling relays & interfaces	11	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	-	-	-
3RS10, 11, 20 & 21 temperature monitoring relay	11	-	-	NKCR	NKCR7	E 44653	-	-	-
3RS17 interface converter	11	<sup>1)</sup>	<sup>1)</sup>	NKCR	NKCR7	E 44653	-	-	-

<sup>1)</sup> c® listing for Canada, instead of CSA certification.

<sup>2)</sup> c® recognition for Canada, instead of CSA certification.

## Standards and Approvals

UL and CSA file numbers and guide card numbers / On-line resources for Industrial Control products

Equipment	SEC	CSA		UL-listed			UL-recognized		
		®	File No.	®	c®	File No.	®	c®	File No.
3RS18 coupling relays	11			NKCR	NKCR7	E 44653			
3RS70 signal converters	11	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653			
3TG10 power relay	11	<sup>1)</sup>	<sup>1)</sup>	NLDX	NLDX7	E 31519			
3TX71 plug-in relays	11						NLDX2	NLDX8	E 14900
3TX71 sockets	11						SWIV2	SWIV8	E 196786
3UG monitoring relay	11	<sup>1)</sup>	<sup>1)</sup>	NKCR	NKCR7	E 44653			
7PV time-delay relay	11	Class 2211 03	LR 12730	NKCR	NKCR7	E 44653			
8WA1 Terminal blocks	12						XCFR2		E 80027
8WA2 & 8WH Terminal blocks	12	Class 3211	LR50181				XCFR2	XCFR8	E 80027
3RK3 MSS	13	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653			
3SE03 North American NEMA) limit switches	13			NKCR		E 47512			
3SE2 hinge switches	13			NKCR	NKCR7	E 44653			
3SE5 limit switches	13	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653	NKCR2	NKCR8	E 44653
3SE6 magnetic monitoring system	13			NKCR	NKCR2	E 44653			
3SE7 rope pull switches	13	<sup>1)</sup>	<sup>1)</sup>	NKCR		E 44653			
3SK safety relays	13			NKCR	NKCR7	E 44653			
3TK28 safety relay	13	<sup>1)</sup>	<sup>1)</sup>	NKCR	NKCR7	E 44653			
AS-Interface components for control circuits, e.g. AS-Interface modules, gateways	14	Class 3211 03	LR 12730	NKCR	NKCR7	E 44653			
AS-Interface components for power cir-cuits, e.g. AS-Interface motor starters, PROFIBUS motor starters	14	Class 3211 04	LR 12730	NLDX	NLDX7	E 31519			
6ED1 programmable relays	15			NRAQ	NRAQ7	E 217227			
6EP1 DC power supplies	15	<sup>1)</sup>	<sup>1)</sup>	NRAQ	NRAQ7	E 143289	NRAQ2	NRAQ8	E 143289
6GK5 ethernet switches	15			NWGQ	NWGQ7	E 115352			
5SJ4 circuit breakers	16			DIVQ	DIVQ7	E 243414			
5ST Aux switch, fault signal contact, shunt trip,busbar	16			DIHS	DIHS7	E 321559	DIHS2	DIHS8	E 321559
5SY4 supplementary protectors	16	<sup>2)</sup>	<sup>2)</sup>				QVNU2	QVNU8	E 116386
3NW70 Fuse Holder	16						IZLT2	IZLT8	E 171267
3NW75 Class CC Fuse Holder	16			IZLT	IZLT7	E 171267			
Sentron circuit breakers	17	Class 1432-01	LR 13077	DIVQ	DIVQ7	E 10848	DKPU2		<sup>3)</sup> E10848
VL circuit breakers	17	Class 1432-01	LR 13077	DIVQ	DIVQ7	E 10848	DKPU2		<sup>3)</sup> E10848
WL circuit breakers	17			DIVQ	DIVQ7	E 231263			
3LD2 disconnect switches	18	<sup>1)</sup>	230576	NLRV	NLRV7	E 47705			
CFS fusible disconnect switches	18		222227	WHTY		E 121152	WHTY2		E 121152
LBR and LBT disconnect switches	18		<sup>1)</sup>	NLRV		E 191706			
MCS disconnect switches	18		154852				WHTY2		E 121152
VBIl disconnect switches	18		154852				WHTY2		E 121152
VBIl safety switches	18		<sup>4)</sup>	WIAX	WIAX7	E 4776			

<sup>1)</sup> c ® listing for Canada, instead of CSA certification.

<sup>2)</sup> c ® recognition for Canada, instead of CSA certification.

<sup>3)</sup> Instantaneous only circuit breakers (ETI or MCP).

<sup>4)</sup> CSA labeled SWS available on request.

## On-Line Resources for Industrial Control Products

## Controls Website

- with links to all sites listed below plus much more

[www.usa.siemens.com/controls](http://www.usa.siemens.com/controls)

## Siemens Industrial Controls Catalog

- with updates to the print Catalog

[www.usa.siemens.com/iccatalog](http://www.usa.siemens.com/iccatalog)

## Siemens Industry Mall

- Quickly search for Siemens control products  
 - Configure products for your application  
 - Create and export a complete Bill of Material for your system  
 - Find helpful technical information, such as:  
 \* Instruction Sheets & Manuals  
 \* 2D & 3D Dimension Drawings

[www.usa.siemens.com/industrymall](http://www.usa.siemens.com/industrymall)

## Industrial Control Panels for North America

- Learn the secrets of control panel design  
 - Improve efficiency in construction and operation of your control panels

[www.usa.siemens.com/controlpaneldesign](http://www.usa.siemens.com/controlpaneldesign)

## Short Circuit Current Ratings (SCCR) to meet UL508A &amp; NEC

- Find the latest High Short Circuit testing for combinations of Siemens Power Distribution & Control Products

<http://www.usa.siemens.com/scsr>

## Siemens Service and Support Website

- Get answers to technical and application questions  
 - Receive training on the latest innovations

<http://support.automation.siemens.com/US>

## General Information

## NEMA enclosure descriptions

**NEMA Standard Publications****No. 250-1979****Type 1**

Type 1 enclosures are intended for indoor use primarily to provide a degree of protection against contact with the enclosed equipment in locations where unusual service conditions do not exist. The enclosures shall meet the rod entry and rust resistance design tests.

**Type 3**

Type 3 enclosures are intended for outdoor use, primarily to provide a degree of protection against wind-blown dust, rain and sleet, and to be undamaged by the formation of ice on the enclosure. They shall meet rain, external icing, dust, and rust resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

**Type 3R**

Type 3R enclosures are intended for outdoor use, primarily to provide a degree of protection against falling rain, and to be undamaged by the formation of ice on the enclosure. They shall meet rod entry, rain, external icing, and rust resistance design tests. They are not intended to provide protection against conditions such as dust, internal condensation, or internal icing.

**Type 4**

Type 4 enclosures are intended for indoor or outdoor use, primarily to provide a degree of protection against windblown dust and rain, splashing water, and hose directed water, and to be undamaged by the formation of ice on the enclosure. They shall meet hosedown, external icing, and rust resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

**Type 4X**

Type 4X enclosures are intended for indoor or outdoor use, primarily to provide a degree of protection against corrosion, windblown dust and rain, splashing water, and hose-directed water, and to be undamaged by the formation of ice on the enclosure. They shall meet hosedown, external icing, and corrosion resistance design tests. They are not intended to provide protection against conditions such as internal condensation or internal icing.

Shall be manufactured of American Iron and Steel Institute Type 304 Stainless steel, polymers, or materials with equivalent corrosion resistance to provide a degree of protection against specific corrosive agents.

**Type 6**

Type 6 enclosures are intended for indoor or outdoor use, primarily to provide a degree of protection against the entry of water during occasional temporary submersion at a limited depth.

Type 6P enclosures are intended for indoor or outdoor use primarily to provide a degree of protection against the entry of water during prolonged submersion at a limited depth.

**Type 7**

Type 7 enclosures are for indoor use in locations classified as Class I, Groups C or D, as defined in the National Electrical Code.

Type 7 enclosures shall be capable of withstanding the pressures resulting from an internal explosion of specified gases and contain such an explosive gas-air mixture existing in the atmosphere surrounding the enclosure will not be ignited. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting explosive gas-air mixtures in the

surrounding atmosphere. Enclosures shall meet explosion, hydrostatic, and temperature design tests.

**Type 9**

Type 9 enclosures are intended for indoor use in locations classified as Class II Groups E, F or G, as defined in the National Electrical Code.

Type 9 enclosures shall be capable of preventing the entrance of dust. Enclosed heat generating devices shall not cause external surfaces to reach temperatures capable of igniting or discoloring dust on the enclosure or igniting dust-air mixtures in the surrounding atmosphere. Enclosures shall meet dust penetration and temperature design tests, and aging of gaskets (if used).

**Class I**—Flammable gases or vapors.

**Class II**—Combustible dust.

**Class III**—Ignitable fibers or flyings.

**Division I**—Normal situation; the hazard would be expected to be present in everyday repair and maintenance.

**Division II**—Abnormal situation; the material is expected to be confined within closed containers or closed systems and will be present only during accidental rupture, breakage or unusual faulty operation.

**Groups**

**Class I**—Gases and vapors are designed for use in groups C and D, depending on the ignition temperature of the substance, its explosion pressure and other flammable characteristics.

**Class II**—Dust locations are designed for use in groups E, F, and G, according to the ignition temperature and conductivity of the hazardous substance.

**Type 12**

Type 12 enclosures are intended for indoor use primarily to provide a degree of protection against dust, falling dirt, and dripping non-corrosive liquids. They shall meet drip, dust, and rust resistance design tests. They are not intended to provide protection against conditions such as internal condensation.

Siemens NEMA 12 may be field modified for outdoor use. NEMA 3 requires the use of watertight conduit hubs. NEMA 3R requires the use of watertight conduit hubs at a level above the lowest live part and drain holes of 1/8" diameter shall be added at the bottom of the enclosure.

**Type 13**

Type 13 enclosures are intended for indoor use primarily to provide a degree of protection against dust, spraying of water, oil and non-corrosive coolant. They shall meet oil explosion and rust resistance design tests. They are not intended to provide protection against conditions such as internal condensation.



Type 1



Type 3/3R



Type 4/4X



Type 4X



Type 3, 4, 7 &amp; 9



Type 12 &amp; 13

# General Information

## IEC enclosure descriptions

### Comparison of NEMA Enclosures

This table summarizes the information provided on the previous page.

Provides a Degree of Protection Against the Following Environmental Conditions	1	3R	4	4X	12	13
Incidental contact with the enclosed equipment	X	X	X	X	X	X
Rain, snow, and sleet	—	X	X	X	—	—
Windblown dust	—	—	X	X	—	—
Falling dirt	X	—	X	X	X	X
Falling liquids and light splashing	—	—	X	X	X	X
Circulating dust, lint, fibers, and flyings	—	—	X	X	X	X
Settling airborne dust, lint, fibers, and flyings	—	—	X	X	X	X
Hosedown and splashing water	—	—	X	X	—	—
Oil and coolant seepage	—	—	—	—	X	X
Oil or coolant spraying and splashing	—	—	—	—	—	X
Corrosive agents	—	—	—	X	—	—

### IEC Environmental Enclosure Ratings for Global Applications

IEC enclosures use a two digit numbering system to define the degree of protection they provide. The first digit specifies the degree of protection against incidental contact and penetration of solid objects. The second digit specifies the level of protection against the ingress of water.

**Example:** An IP65 enclosure is dust tight and protected against water jets. An IP66 enclosure is dust tight and protected against powerful water jets.

First Numeral	Second Numeral
<b>Protection of persons against access to hazardous parts and protection against penetration of solid foreign objects.</b>	<b>Protection against ingress of water under test conditions specified in IEC 529.</b>
0 Non-protected	0 Non-protected
1 Back of hand; objects greater than 50 mm in diameter	1 Vertically falling drops of water
2 Finger; objects greater than 12.5 mm in diameter	2 Vertically falling drops of water with enclosure tilted 15 degrees
3 Tools or objects greater than 2.5 mm in diameter	3 Spraying water
4 Tools or objects greater than 1 mm in diameter	4 Splashing water
5 Dust-protected (Dust may enter but must not interfere with operation of the equipment or impair safety)	5 Water jets
6 Dust tight (No dust observable inside enclosure at end of test)	6 Powerful water jets
	7 Temporary submersion
	8 Continuous submersion

### Comparison of NEMA Type Numbers to IEC Classification Designations

This table shows the IP classification designation to which NEMA enclosures may be applied. The table cannot be used to convert IEC designations to NEMA type numbers.

NEMA Enclosure Type Number	IEC Enclosure Classification Designation
1	IP10
3	IP54
3R	IP54
4 and 4X	IP56
6 and 6P	IP67
12	IP52
13	IP54

## General Information

## IEC contactor utilization categories

Contactors designed for international applications are tested and rated per IEC 947-4. The IEC rating system is broken down into different utilization categories that define the value of the current that the contactor must make, maintain, and break. The following category definitions are the most commonly used for IEC Contactors.

Ratings for Siemens contactors per these categories can be found in Section 3.

## AC Categories

## AC-1

This applies to all AC loads where the power factor is at least 0.95. These are primarily non-inductive or slightly inductive loads. Breaking remains easy.

## AC-3

This category applies to squirrel cage motors where the breaking of the power contacts would occur while the motor is running. On closing, the contactor experiences an inrush which is 5 to 8 times the nominal motor current, and at this instant, the voltage at the terminals is approximately 20% of the line voltage. Breaking remains easy.

## AC-4

This applies to the starting and breaking of a squirrel cage motor during an inch or plug reverse. On energization, the contactor closes on an inrush current approximately 5 to 8 times the nominal current. On de-energization, the contactor breaks the same magnitude of nominal current at a voltage that can be equal to the supply voltage. Breaking is severe.

## DC Categories

## DC-1

This applies to all DC loads where the time constant (L/R) is less than or equal to one msec. These are primarily noninductive or slightly inductive loads.

## DC-2

This applies to the breaking of shunt motors while they are running. On closing, the contactor makes the inrush current around 2.5 times the nominal rated current. Breaking is easy.

## DC-3

This applies to the starting and breaking of a shunt motor during inching or plugging. The time constant shall be less than or equal to 2 msec. On energization, the contactor sees current similar to that in Category DC-2. On de-energization, the contactor

will break around 2.5 times the starting current at a voltage that may be higher than the line voltage. This would occur when the speed of the motor is low because the back e.m.f. is low. Breaking is severe.

## DC-5

This applies to the starting and breaking of a series motor during inching or plugging. The time constant being less than or equal to 7.5 msec. On energization, the contactor sees about 2.5 times the nominal full load current. On de-energization, the contactor breaks the same amount of current at a voltage which can be equal to the line voltage. Breaking is severe.

## Special Contactor Utilization Categories

Some contactors also have ratings for the following specialty utilization categories.

For specific applications, please contact your local Siemens sales office.

Kind of Current	Utilization Categories	Typical Applications
AC	AC-2	Slip-ring motors: starting, switching off
	AC-5a	Switching of electric discharge lamp controls
	AC-5b	Switching of incandescent lamps
	AC-6a	Switching of transformers, welders
	AC-6b	Switching of capacitor banks
	AC-7a	Slightly inductive loads in household appliances and similar applications
	AC-7b	Motor-loads for household applications
	AC-8a	Hermetic refrigerant compressor motor <sup>1)</sup> control with manual resetting of overload releases
	AC-8b	Hermetic refrigerant compressor motor <sup>1)</sup> control with automatic resetting of overload releases
DC	DC-6	Switching of incandescent lamps

## Electrical Quantities Symbols According to DIN, VDE and IEC

Symbol	Characteristic Electrical Quantity	Symbol	Characteristic Electrical Quantity
$U_i$	Rated insulation voltage to DIN VDE 0110/DIN VDE 0660	$I_{sw}$	Rated short-time current withstand capacity to IEC 947-1
$U_o$	Rated operational voltage	$I_p$	Test current (general) to DIN VDE 0660, prospective current to DIN VDE 0636
$U_c$	Rated control voltage (IEC 947-1) at which an operating mechanism or release is rated, e.g. coil voltage to DIN VDE 0660 Part 102	$I_n$	Breaking current (r.m.s. value) to DIN VDE 0102
$U_s$	Rated control supply voltage (Control voltage) to DIN VDE 0660 Part 102, IEC 947-1	$i_p$	Peak short-circuit current (maximum instantaneous value) to DIN VDE 0102
$U$	No-load voltage to IEC 947-2, -3, -5	$I_k$	Sustained (symmetrical) short-circuit current (r.m.s. value), DIN VDE 0102.
$U_r$	Power-frequency recovery voltage (IEC 947-.)	$I_{sw}$	Rated short-time withstand current to DIN VDE 0660
$U_o$	Transformer no-load voltage to DIN VDE 0532	$i_p$	Let-through current of fuses and rapidly operating switching devices (maximum instantaneous value during the break time) to DIN VDE 0102
$U_k$	Short-circuit impedance voltage to DIN VDE 0532	$I_o$	No-load current at the input side of a transformer (unloaded output side) to DIN VDE 0532
$U_{kr}$	Rated value of the impedance voltage in % to DIN VDE 0102, 01.90	$I_x$	Current carrying capacity (ampacity)
$I_n$	Rated current to IEC 947-.	$I_{sr}$	Rated rotor operational current (DIN VDE 0660, IEC 947-1)
$I_{th}$	Eight-hour-current to DIN VDE 0660, conventional free-air thermal current to IEC 947- (defined as eight-hour-current) thermally equivalent short-time current (r.m.s. value) to DIN VDE 0103	$I_r$	Setting current ("current setting") to DIN VDE 0660
$I_{the}$	Conventional enclosed thermal current	$I_B$	Take-over current
$I_u$	Rated uninterrupted current to IEC 947-1	R	Ohmic resistance
$I_s$	Rated operational current	$S_n^k$	Initial symmetrical AC short-circuit power (simplified: apparent short-circuit power)
$I_s$	Selectivity (discrimination) limit current (DIN VDE 0660, IEC 947-1)	X	Reactance, reactive impedance
$I_{cm}$	Rated short-circuit making capacity to IEC 947-1	Z	Impedance (apparent resistance)
$I_{cn}$	Rated short-circuit breaking capacity to IEC 947-1	x	Factor to determine the peak short-circuit current $i_p$
$I_{cm}$	Rated ultimate short-circuit breaking capacity to IEC 947-1		

1) Hermetic refrigerant compressor motor is a combination consisting of a compressor and a motor, both of which are enclosed in the same housing, with no external shaft or shaft seals, the motor operating in the refrigerant.

# General Information

## NEMA and IEC control circuit classifications

### AC-Control Circuit Classifications—NEMA

NEMA designates Control Circuit Rating with a code letter (for current) and a voltage code.

Rating & Test Values for AC Control Circuit Contacts at 50 or 60Hz

Contact Rating Designation	Thermal Continuous Test Current, Amperes	Maximum Current, Amperes								Voltamperes	
		120 Volts		240 Volts		480 Volts		600 Volts		Make	Break
		Make	Break	Make	Break	Make	Break	Make	Break		
A150	10	60	6	—	—	—	—	—	—	7200	720
A300	10	60	6	30	3	—	—	—	—	7200	720
A600	10	60	6	30	3	15	1.5	12	1.2	7200	720
B150	5	30	3	—	—	—	—	—	—	3600	360
B300	5	30	3	15	1.5	—	—	—	—	3600	360
B600	5	30	3	15	1.5	7.5	0.75	6	0.6	3600	360
C150	2.5	15	1.5	—	—	—	—	—	—	1800	180
C300	2.5	15	1.5	7.5	0.75	—	—	—	—	1800	180
C600	2.5	15	1.5	7.5	0.75	3.75	0.375	3	0.3	1800	180
D150	1	3.6	0.6	—	—	—	—	—	—	432	72
D300	1	3.6	0.6	1.8	0.3	—	—	—	—	432	72
E150	0.5	1.8	0.3	—	—	—	—	—	—	216	36

### DC-Control Circuit Classifications—NEMA

Rating codes for DC Control Circuit Contacts

Contact Rating Designation <sup>1)</sup>	Thermal Continuous Test Current, Amperes	Maximum Make or Break <sup>2)</sup> Current, Amperes			Maximum Make or Break Voltamperes at 300 Volts or Less
		125 Volt	250 Volt	301 to 600 Volt	
		N150	10	2.2	
N300	10	2.2	1.1	—	275
N600	10	2.2	1.1	0.4	275
P150	5	1.1	—	—	138
P300	5	1.1	0.55	—	138
P600	5	1.1	0.55	0.2	138
Q150	2.5	0.55	—	—	69
Q300	2.5	0.55	0.27	—	69
Q600	2.5	0.55	0.27	0.1	69
R150	1	0.22	—	—	28
R300	1	0.22	0.11	—	28

### Control Circuit Classifications—IEC<sup>3)</sup>

IEC 947-5-1 Uses Utilization Categories AC-15 to Specify Control Circuit Ranges.

Current at each voltage is specified by the manufacturer, not by the standard.

AC Control Circuit Utilization Categories per IEC 947-5-1	Make				Break				DC Control Circuit Utilization Categories per IEC 947-5-1	Make		Break	
	I <sub>o</sub> /U <sub>o</sub>		U/U <sub>o</sub>		I <sub>o</sub> /U <sub>o</sub>		U/U <sub>o</sub>			I <sub>o</sub> /U <sub>o</sub>	U/U <sub>o</sub>	I <sub>o</sub> /U <sub>o</sub>	U/U <sub>o</sub>
	I <sub>o</sub>	U <sub>o</sub>	I <sub>o</sub>	U <sub>o</sub>	I <sub>o</sub>	U <sub>o</sub>	I <sub>o</sub>	U <sub>o</sub>					
AC-12	1	1	1	1	1	1	1	1	1	1	1	1	
AC-13	2	1	1	1	1	1	1	1	1	1	1	1	
AC-14	6	1	1	1	1	1	1	10	1	1	1	1	
AC-15	10	1	1	1	1	1	1	—	—	—	—	—	

### Example of a Typical IEC Control Circuit Ratings Table<sup>4)</sup>

AC			DC		
I <sub>o</sub> /AC-12 (Continuous Amps)	U <sub>o</sub> AC Voltage	I <sub>o</sub> /AC-15 Amps	Voltage	I <sub>o</sub> /DC-12	I <sub>o</sub> /DC-13
10	24V	6A	24	6A	3A
	110V	6A	60	5A	1.5A
	220/230V	6A	110	2.5A	0.7A
	380/440V	4A	230	1A	0.3A

1)The numerical suffix designates the maximum voltage design values, which are to be 600, 300, and 150 volts for suffixes 600, 300, and 150 respectively. Test voltage shall be 600, 250, or 125 volts. MLLDLL.

2)For maximum ratings at 300 volts or less, the maximum make and break ratings are to be obtained by dividing the volt-ampere rating by the application voltage, but the current value is not to exceed the thermal continuous test current.

3) I<sub>o</sub> Rated operational current  
U<sub>o</sub> Rated operational voltage  
I Current to be made or broken  
U Voltage before make

4)Example: A control circuit contact having an AC-15 rating of 6 amps at 230 volts is capable of making 60 amps and breaking 6 amps at 230 volts. KRE.

## General Information

## Ampere ratings for 3 phase AC induction motors

## 3 Phase

Amperes 60Hz						Amperes 60Hz						
Hp	Syn Speed RPM	200 Volts	230 Volts	460 Volts	575 Volts	Hp	Syn Speed RPM	200 Volts	230 Volts	460 Volts	575 Volts	
¼	1800	1.09	0.95	0.48	0.38	25	3600	69.9	60.8	30.4	24.3	
	1200	1.61	1.40	0.70	0.56		1800	74.5	64.8	32.4	25.9	
	900	1.84	1.60	0.80	0.64		1200	75.4	65.6	32.8	26.2	
⅓	1800	1.37	1.19	0.60	0.48		900	77.4	67.3	33.7	27.0	
	1200	1.83	1.59	0.80	0.64		30	3600	84.8	73.7	36.8	29.4
	900	2.07	1.80	0.90	0.72			1800	86.9	75.6	37.8	30.2
1800	1.98	1.72	0.86	0.69	1200			90.6	78.8	39.4	31.5	
½	1200	2.47	2.15	1.08	0.86		900	94.1	81.8	40.9	32.7	
	900	2.74	2.38	1.19	0.95		40	3600	111	96.4	48.2	38.5
	1800	2.83	2.46	1.23	0.98			1800	116	101	50.4	40.3
1200	3.36	2.82	1.46	1.17	1200			117	102	50.6	40.4	
¾	900	3.75	3.26	1.63	1.30		900	121	105	52.2	41.7	
	1	3600	3.22	2.80	1.40	1.12	50	3600	138	120	60.1	48.2
		1800	4.09	3.56	1.78	1.42		1800	143	124	62.2	49.7
1200		4.32	3.76	1.88	1.50	1200		145	126	63.0	50.4	
900	4.95	4.30	2.15	1.72	900	150	130	65.0	52.0			
1 ½	3600	5.01	4.36	2.18	1.74	60	3600	164	143	71.7	57.3	
	1800	5.59	4.86	2.43	1.94		1800	171	149	74.5	59.4	
	1200	6.07	5.28	2.64	2.11		1200	173	150	75.0	60.0	
900	6.44	5.60	2.80	2.24	900	177	154	77.0	61.5			
2	3600	6.44	5.60	2.80	2.24	75	3600	206	179	89.6	71.7	
	1800	7.36	6.40	3.20	2.56		1800	210	183	91.6	73.2	
	1200	7.87	6.84	3.42	2.74		1200	212	184	92.0	73.5	
900	9.09	7.90	3.95	3.16	900	222	193	96.5	77.5			
3	3600	9.59	8.34	4.17	3.34	100	3600	266	231	115	92.2	
	1800	10.8	9.40	4.70	3.76		1800	271	236	118	94.8	
	1200	11.7	10.2	5.12	4.10		1200	275	239	120	95.6	
900	13.1	11.4	5.70	4.55	900	290	252	126	101			
5	3600	15.5	13.5	5.76	5.41	125	3600	—	292	146	116	
	1800	16.6	14.4	7.21	5.78		1800	—	293	147	117	
	1200	18.2	15.8	7.91	6.32		1200	—	298	149	119	
900	18.3	15.9	7.92	6.33	900	—	305	153	122			
7 ½	3600	22.4	19.5	9.79	7.81	150	3600	—	343	171	137	
	1800	24.7	21.5	10.7	8.55		1800	—	348	174	139	
	1200	25.1	21.8	10.9	8.70		1200	—	350	174	139	
900	26.5	23.0	11.5	9.19	900	—	365	183	146			
10	3600	29.2	25.4	12.7	10.1	200	3600	—	458	229	184	
	1800	30.8	25.8	13.4	10.7		1800	—	452	226	181	
	1200	32.2	28.0	14.0	11.2		1200	—	460	230	184	
900	35.1	30.5	15.2	12.2	900	—	482	241	193			
15	3600	41.9	36.4	18.2	14.5	250	3600	—	559	279	223	
	1800	45.1	39.2	19.6	15.7		1800	—	568	284	227	
	1200	47.6	41.4	20.7	16.5		1200	—	573	287	229	
900	51.2	44.5	22.2	17.8	900	—	600	300	240			
20	3600	58.0	50.4	25.2	20.1	300	1800	—	278	339	271	
	1800	58.9	51.2	25.6	20.5		1200	—	684	342	274	
	1200	60.7	52.8	26.4	21.1		400	1800	—	896	448	358
900	63.1	54.9	27.4	21.9								

Full load ampere ratings of motors vary depending upon a number of factors. The full load currents listed above are “average values” for horsepower rated motors of several manufacturers at the most commonly rated voltages and speeds. These “average values” along with the similar values listed in the N.E.C. should be used as a guide only for selecting suitable components for the motor branch circuit. The rated full load current shown on the motor nameplate

may vary considerably from the listed value, depending on the specified motor design.

**Note: RPM shown for 60Hz motors. For 50Hz motors, multiply the 60HZ FLA value by 1.2.**

#### Overload Relay Selection Multi-Speed/Part-Winding/Wye-Delta

Special attention should be given to the selection of the overload relay adjustment range for multi-speed, part-winding and wye-delta controllers, as follows:

**Multi-Speed Controllers:** Each speed requires a separate set of overloads. The adjustment range must be selected on the basis of the full-load current for each particular speed.

**Part-Winding Controllers:** Each winding of the motor must have its own set of overloads. The adjustment range should be selected on the basis of one-half the motor full-load current; that is, the full load current of each winding current.

**Wye-Delta Controllers:** Only one set of overloads is required. Since the overload relay is located electrically “inside the delta connection,” the adjustment range must be selected on the basis of the full-load motor current (delta connection) divided by 1.73.

**Single Phase:** See page 9/120 for ampere ratings of single phase AC induction motors.



# General Information

## Metric to US conversions

### Wire Conversion Table

#### Comparison of Cross-sectional Areas to Metric and US Standards

Metric Cross-sectional Areas (in line with VDE)		American Wire Gauge	
Cross-sectional Area mm <sup>2</sup>	Equivalent Metric C.S.A. mm <sup>2</sup>	AWG or MCM	
0.75	0.635		<b>19 AWG</b>
	0.823		<b>18</b>
	1.04		<b>17</b>
1.5	1.31		<b>16</b>
	1.65		<b>15</b>
	2.08		<b>14</b>
2.5	2.62		<b>13</b>
	3.31		<b>12</b>
4	4.17		<b>11</b>
	5.26		<b>10</b>
6	6.63		<b>9</b>
	8.37		<b>8</b>
10	10.55		<b>7</b>
	13.30		<b>6</b>
16	16.77		<b>5</b>
	21.15		<b>4</b>
25	26.67		<b>3</b>
	33.63		<b>2</b>
35	42.41		<b>1</b>
	53.48		<b>1/0</b>
50	67.43		<b>2/0</b>
	85.03		<b>3/0</b>
70	107.20		<b>4/0</b>
	126.64		<b>250 MCM</b>
150	152.00		<b>300</b>
	177.35		<b>350</b>
185	202.71		<b>400</b>
	253.35		<b>500</b>
240	304.00		<b>600</b>
	354.71		<b>700</b>
400	405.35		<b>800</b>
	506.71		<b>1000</b>
500			
625			

### Other Conversions

Power Conversions		
1 kilowatt (kW)	=	1.341 horsepower (hp)
1 horsepower (hp)	=	0.7457 kilowatt (kW)
Dimensions Conversions		
1 inch (in.)	=	25.4 millimeters (mm)
1 inch (in.)	=	2.54 centimeters (cm)
1 centimeter (cm)	=	0.3937 inches (in.)
1 meter (m)	=	39.37 inches (in.)
Weight Conversions		
1 ounce (oz.)	=	28.35 grams (g)
1 pound (lb.)	=	0.454 kilograms (kg)
1 kilogram (kg)	=	2.205 pounds (lbs.)
Temperature Conversions		
100 Celsius	=	212 Fahrenheit
80 Celsius	=	176 Fahrenheit
60 Celsius	=	140 Fahrenheit
40 Celsius	=	104 Fahrenheit
20 Celsius	=	68 Fahrenheit
0 Celsius	=	32 Fahrenheit
Torque		
1 Newton-meter (Nm)	=	8.85 pound-inches (lb. in.)

# General Information

## Electrical formulas and grounding requirements

### Electrical Formulas for Finding Amperes, Horsepower, Kilowatts and kVA

To Find	Single-Phase	Alternating Current Two-Phase <sup>1)</sup> , Four-Wire	Three-Phase	Direct Current
Kilowatts	$\frac{I \times E \times pf}{1000}$	$\frac{I \times E \times 2 \times pf}{1000}$	$\frac{I \times E \times 1.73 \times pf}{1000}$	$\frac{I \times E}{1000}$
kVA	$\frac{I \times E}{1000}$	$\frac{I \times E \times 2}{1000}$	$\frac{I \times E \times 1.73}{1000}$	—
Horsepower (Output)	$\frac{I \times E \times \% \text{ EFF} \times pf}{746}$	$\frac{I \times E \times 2 \times \% \text{ EFF} \times pf}{746}$	$\frac{I \times E \times 1.73 \times \% \text{ EFF} \times pf}{746}$	$\frac{I \times E \times \% \text{ EFF}}{746}$
Amperes when Horsepower is Known	$\frac{HP \times 746}{E \times \% \text{ EFF} \times pf}$	$\frac{HP \times 746}{2 \times E \times \% \text{ EFF} \times pf}$	$\frac{HP \times 746}{1.73 \times E \times \% \text{ EFF} \times pf}$	$\frac{HP \times 746}{E \times \% \text{ EFF}}$
Amperes when Kilowatts is Known	$\frac{KW \times 1000}{E \times pf}$	$\frac{KW \times 1000}{2 \times E \times pf}$	$\frac{KW \times 1000}{1.73 \times E \times pf}$	$\frac{KW \times 1000}{E}$
Amperes when kVA is Known	$\frac{kVA \times 1000}{E}$	$\frac{kVA \times 1000}{2 \times E}$	$\frac{kVA \times 1000}{1.73 \times E}$	—

### Average Efficiency and Power Factor Values of Motors

When the actual efficiencies and power factors of the motors to be controlled are not known, the following approximations may be used.

#### Efficiencies<sup>3)</sup>

Type	Power Factor
DC motors, 35 horsepower and less	80% to 85%
DC motors, above 35 horsepower	85% to 90%
Synchronous motors (at 100% power factor)	92% to 95%
"Apparent" Efficiencies (= Efficiency × Power Factor); Three-phase induction motors, 25 horsepower and less	70%
Three-phase induction motors above 25 horsepower	80%

### Fault-Current Calculation on Low-Voltage AC Systems

In order to determine the maximum interrupting rate of the circuit breakers in a distribution system, it is necessary to calculate the current which could flow under a three-phase bolted short circuit condition. For a three-phase system the maximum available fault current at the secondary side of the transformer can be obtained by use of the formula:

$$I_{SC} = \frac{kVA \times 100}{KV \times \sqrt{3} \times \% Z}$$

where: —

$I_{SC}$  = Symmetrical RMS amperes of fault current.

kVA = Kilovolt-ampere rating of transformers.

KV = Secondary voltage in kilovolts.

% Z = Percent impedance of primary line and transformer.

### Minimum Size Grounding Conductors for Grounding Raceways and Equipment (From NEC Table 250-95)<sup>2)</sup>

Rating or Setting of Automatic Overcurrent Device in Circuit Ahead of Equipment, Conduit etc., Not Exceeding (Amperes)	Size	
	Copper Wire Number	Aluminum or Copper Clad Aluminum Wire Number
15	14	12
20	12	10
30	10	8
40	10	8
60	10	8
100	8	6
200	6	4
300	4	2
400	3	1
500	2	1/0
600	1	2/0
800	1/0	3/0
1000	2/0	4/0
1200	3/0	250 kcmil
1600	4/0	350 kcmil
2000	250 kcmil	400 kcmil
2500	350 kcmil	600 kcmil
3000	400 kcmil	600 kcmil
4000	500 kcmil	800 kcmil
5000	700 kcmil	1200 kcmil
6000	800 kcmil	1200 kcmil

### Grounding Electrode Conductor for AC Systems (From NEC Table 250-94)<sup>2)</sup>

Size of Largest Service Entrance Conductor or Equivalent Area for Parallel Conductors		Size of Grounding Electrode Conductor	
Copper	Aluminum or Copper Clad Aluminum	Copper	Aluminum or Copper Clad Aluminum
2 or smaller	1/0 or smaller	8	6
1 or 1/0	2/0 or 3/0	6	4
2/0 or 3/0	4/0 or 250 kcmil	4	2
Over 3/0 to 350 kcmil	Over 250 kcmil to 500 kcmil	2	1/0
Over 350 kcmil to 600 kcmil	Over 500 kcmil to 900 kcmil	1/0	3/0
Over 600 kcmil to 1100 kcmil	Over 900 kcmil to 1750 kcmil	2/0	4/0
Over 1100 kcmil	Over 1750 kcmil	3/0	250 kcmil

1)In three-wire, two-phase circuits the current in the common conductor is 1.41 times that in either other conductor.

E = Volts I = Amperes  
% EFF = Percent Efficiency pf = Power Factor

2)Additional information and exceptions are stated in Article 250—Grounding, National Electric Code.

3)These figures may be decreased slightly for single-phase and two-phase induction motors.

# General Information

## NEMA and IEC terminal markings

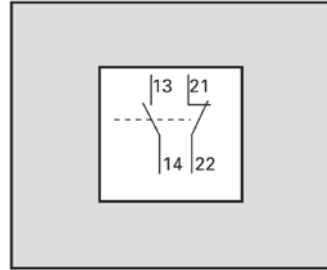
### Symbols and Terminal Markings—IEC

Per DIN standards, the terminals of auxiliary contacts on contactors and control devices are marked with a two digit number. Terminals that belong together are marked with the same location digit (first digit).

The second digits (called the function digits) identify the function of each contact per the following designation.

Type of Contact	Function Digits
Normally Open	3 and 4
Normally Closed	1 and 2
Normally Open (Special Function)	5 and 6 i.e. Time-Delay or Overload
Normally Closed (Special Function)	7 and 8 Contacts

#### Example:

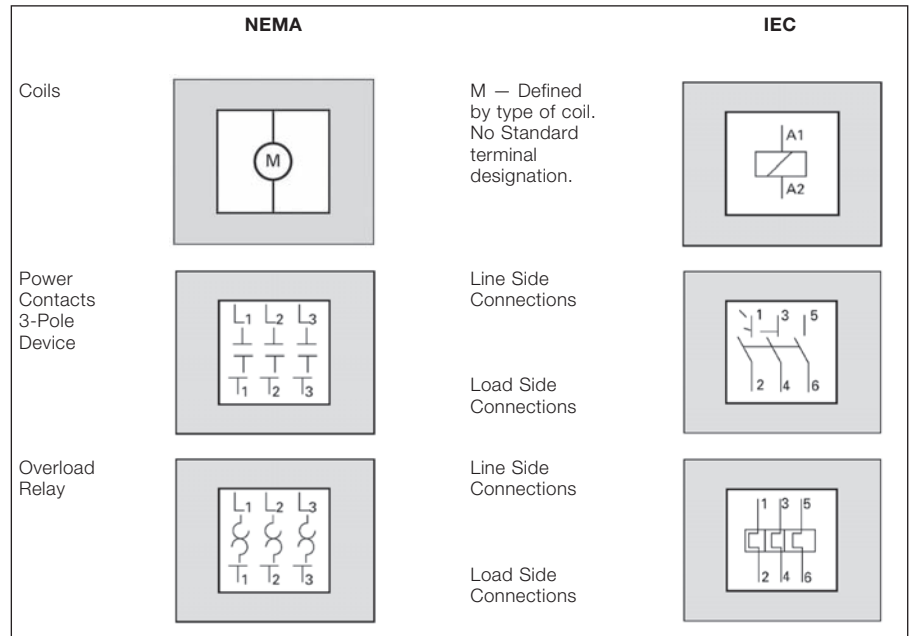


1. The numbers 13 and 14 represent an auxiliary contact
2. The number 1 identifies that this is the first contact in the sequence
3. The numbers 3 and 4 identify this as a normally open contact
4. The numbers 21 and 22 represent another auxiliary contact
5. The number 2 identifies that this is the second contact in the sequence
6. The numbers 1 and 2 identify this as a normally closed contact

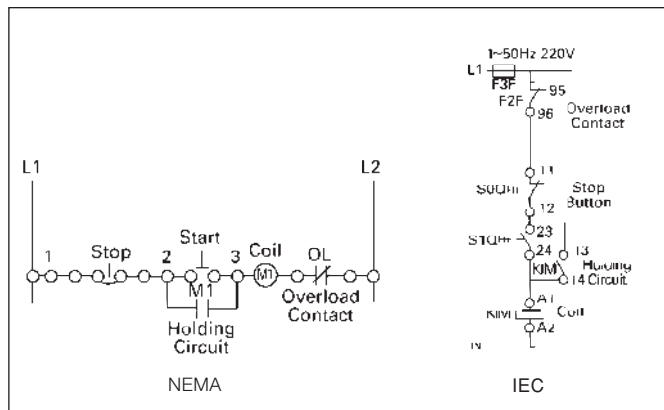
### Symbols and Terminal Markings

Control Circuits	NEMA	IEC
Normally Open (NO)		
Normally Closed (NC)		
<b>Time Delay Circuits</b>		
On Delay Normally Open (Timed Closed)		
Normally Closed (Timed Open)		
Off Delay Normally Open (Timed Open)		
Normally Closed (Timed Closed)		

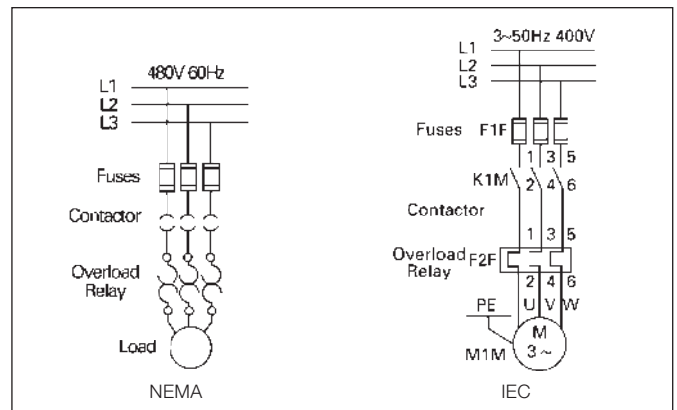
### NEMA and IEC Comparisons Contactor/Starter Markings



### Control Circuit Schematic

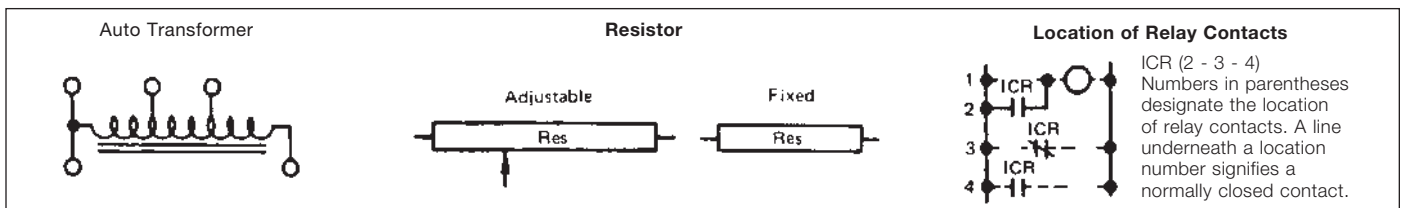
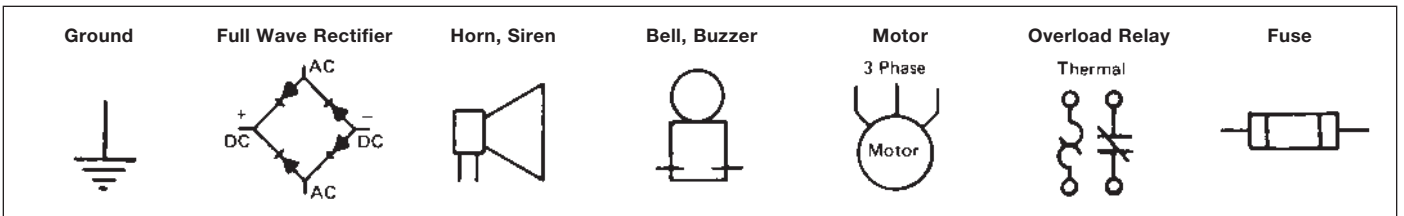
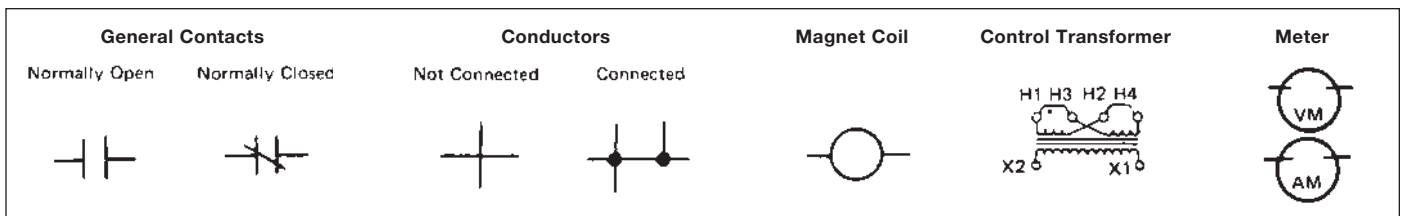
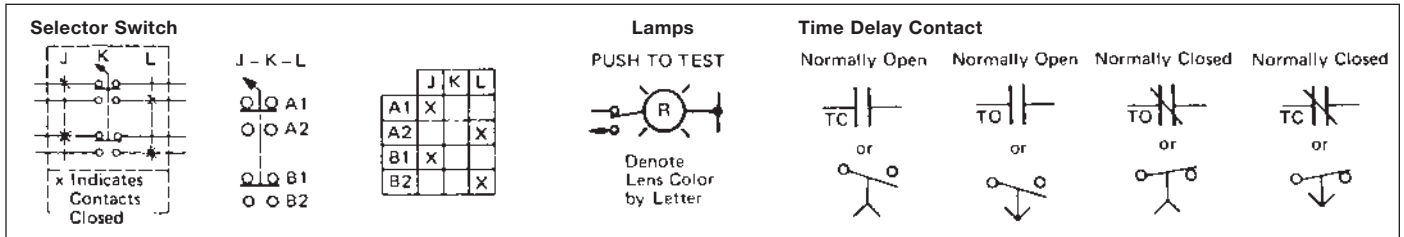
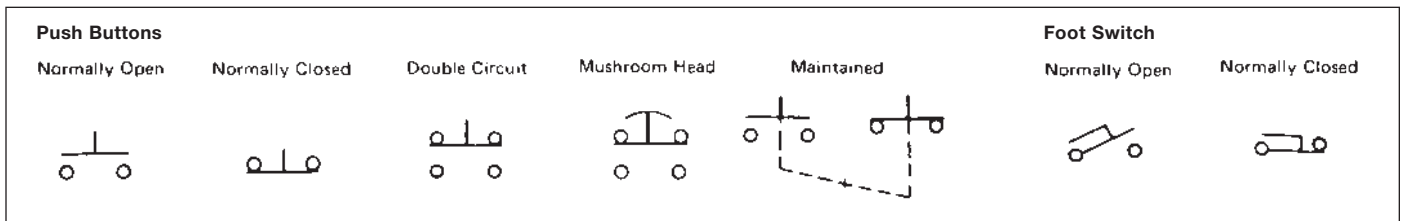
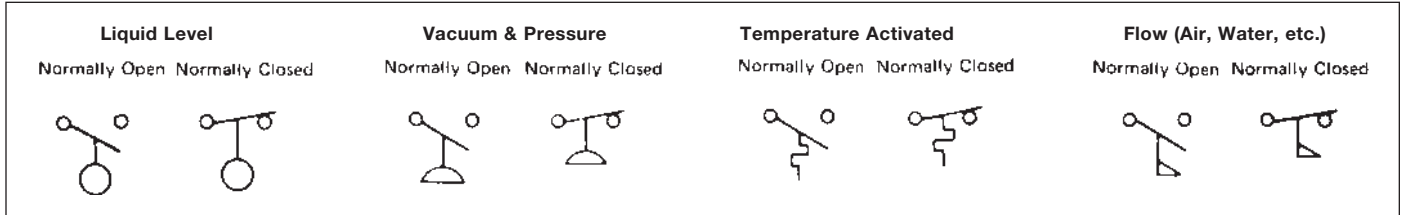
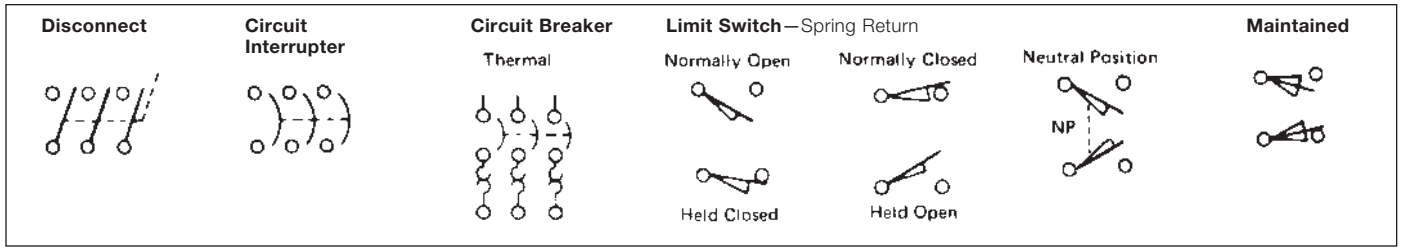


### Power Circuit Schematic



# General Information

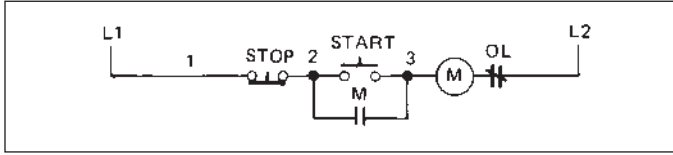
## Electrical symbols



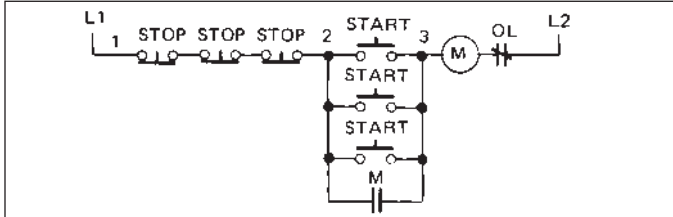
# General Information

## Control circuit schematics

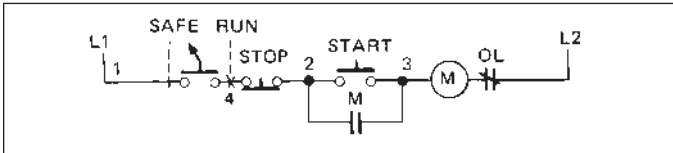
**Figure 1** Three Wire Control Giving Low Voltage Protection Using Single Two Button Station



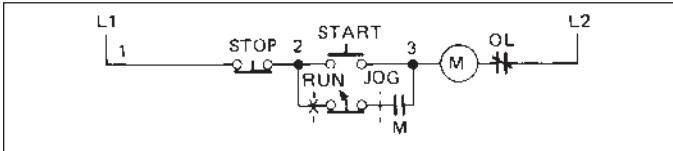
**Figure 2** Three Wire Control Giving Low Voltage Protection Using Multiple Two Button Stations



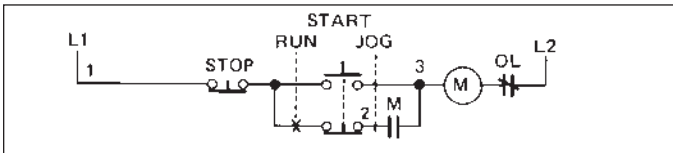
**Figure 3** Three Wire Control Giving Low Voltage Protection with Safe-Run Selector Switch



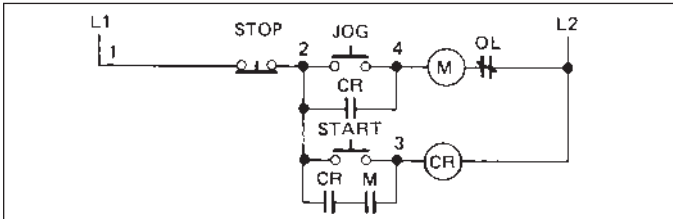
**Figure 4** Three Wire Control for Jog or Run Using Start Stop Push Buttons and Jog-Run Selector Switch



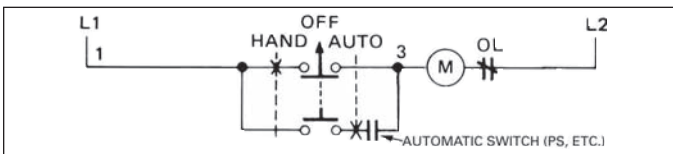
**Figure 5** Control for Jog or Run Using Stop Push Button and Jog-Run Selector Push Selector Switch. Selector Push Contacts are Shown for "Run" (Three Wire Operation). Rotate Switch Sleeve and Selector Contact Opens Between "2" and "Stop" Button (Two Wire Operation)



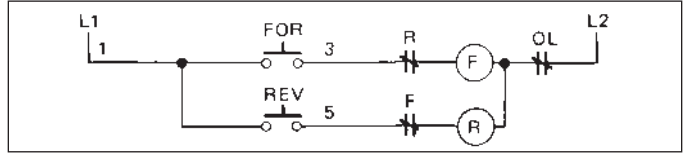
**Figure 6** Three Wire Control for Jogging, Start, Stop Using Push Buttons



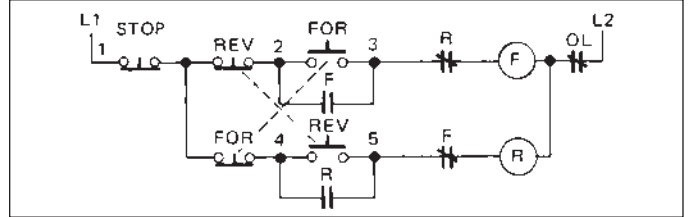
**Figure 7** Two Wire Control Giving Low Voltage Release Only Using Hand-Off-Auto Selector Switch



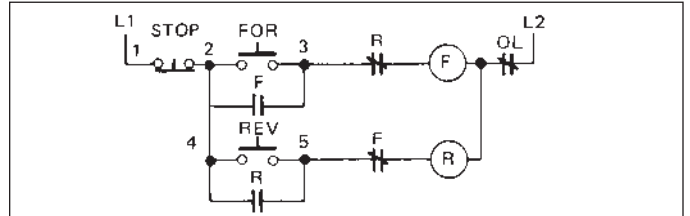
**Figure 8** Two Wire Control for Reversing Jogging Using Single Two Button Station



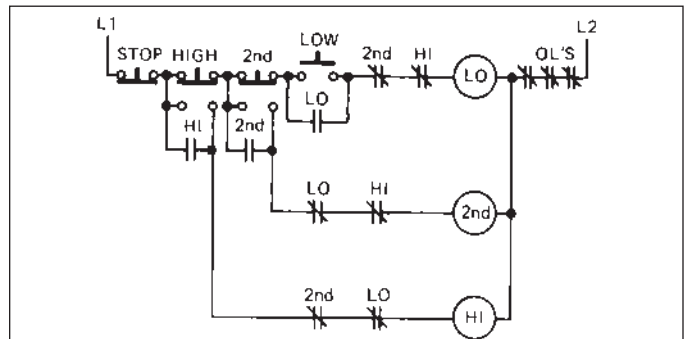
**Figure 9** Three Wire Control for Instant Reversing Applications Using Single Three Button Station



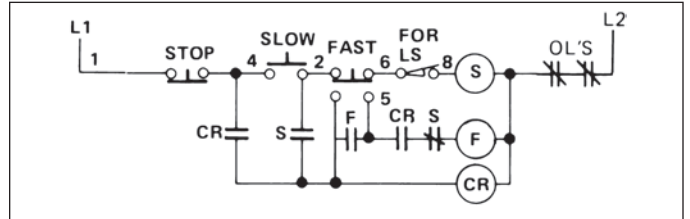
**Figure 10** Three Wire Control for Reversing After Stop Using Single Three Button Station



**Figure 11** Control for Three Speed with Selective Circuitry to Insure the Stop Button is Pressed Before Going to a Lower Speed



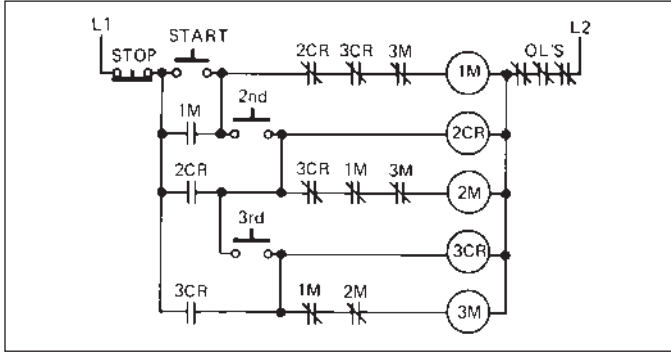
**Figure 12** Three Wire Control for Two Speed with a Compelling Relay to Insure Starting on Slow Speed



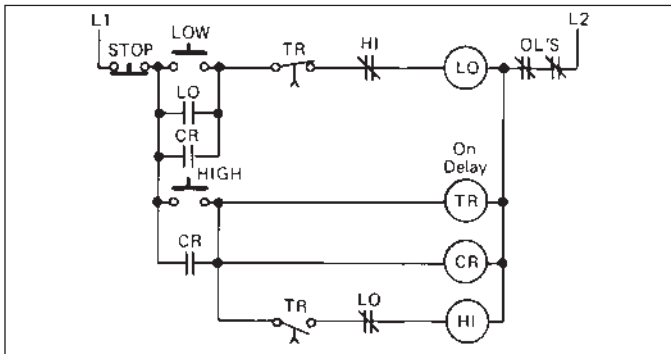
# General Information

## Control circuit schematics and wiring diagrams with transformers

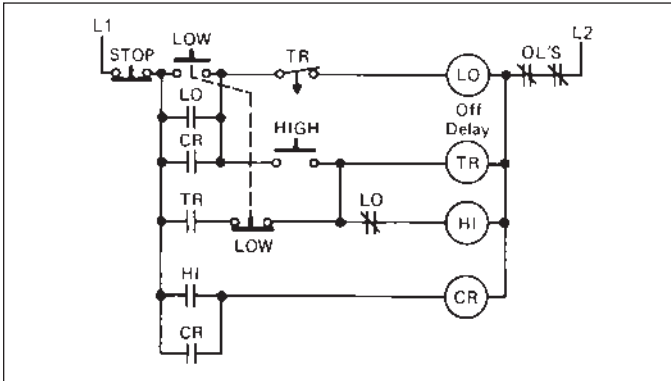
**Figure 13** Control for Three Speed with a Compelling Relay to Insure Starting on Low Speed



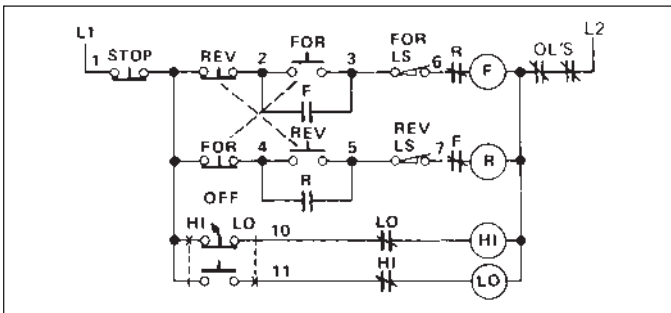
**Figure 14** Control for Two Speed to Provide Automatic Acceleration from Low to High Speed



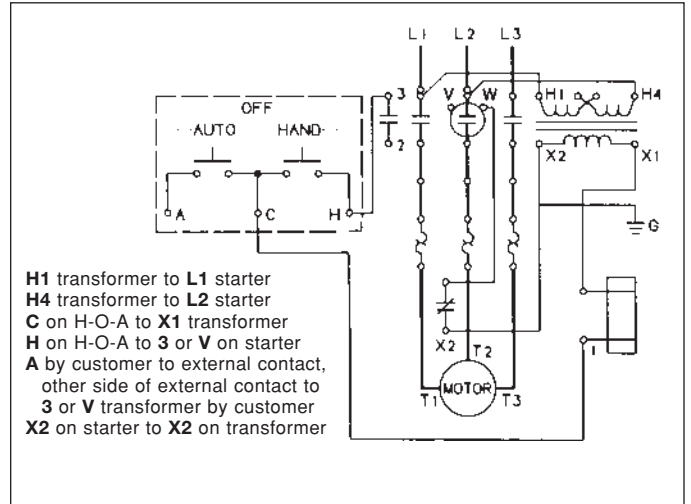
**Figure 15** Control for Two Speed to Provide Automatic Deceleration from High to Low Speed



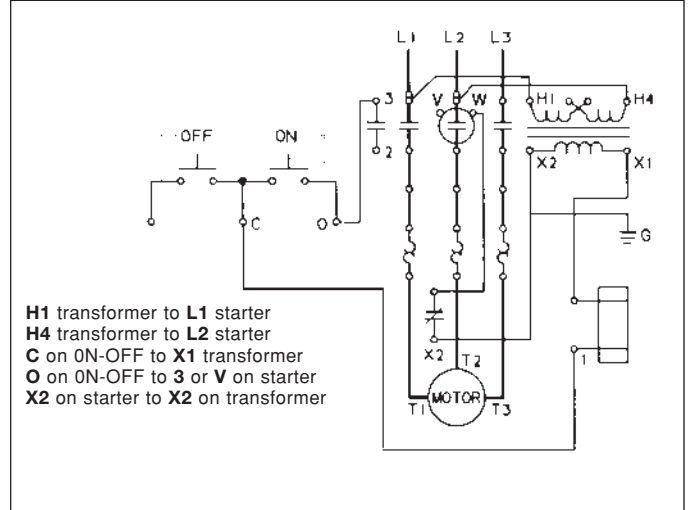
**Figure 16** Control for Two Speed Reversing Starter Using Forward, Reverse, Stop Push Buttons and High-Low-Off Selector Switch



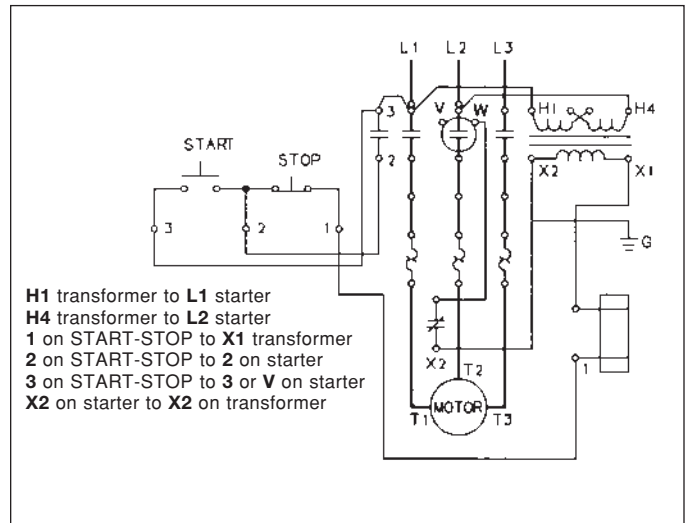
**Size 0-2½ Starter with Transformer and 3 Position Selector Switch**



**Size 0-2½ Starter with Transformer and 2 Position Selector Switch**



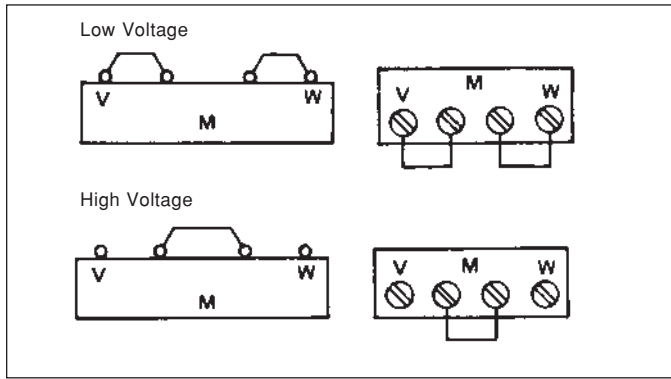
**Size 0-2½ Starter with Transformer and START-STOP Push Button**



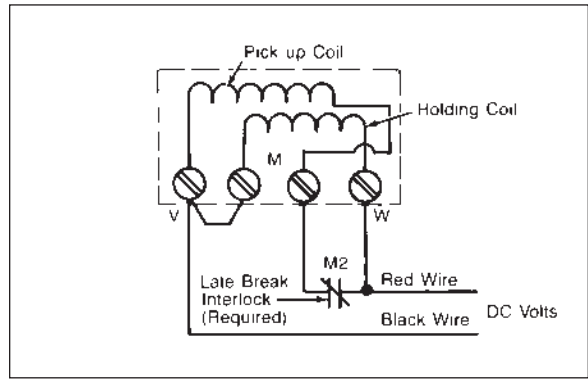
# General Information

## Pilot control

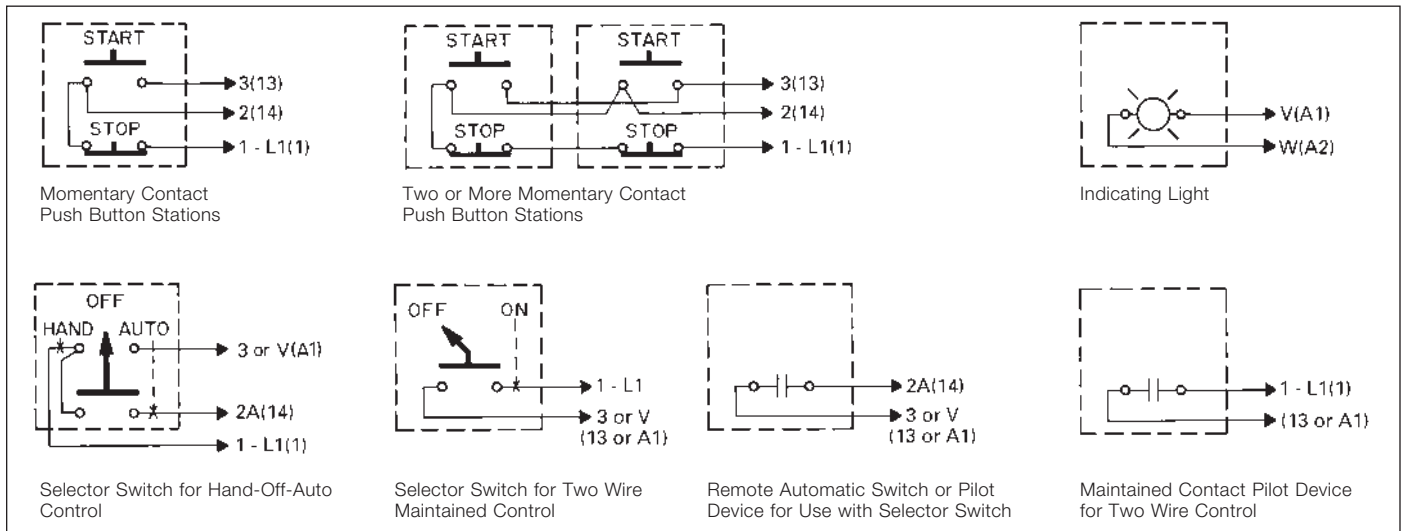
### AC Coil—NEMA Size 0-4



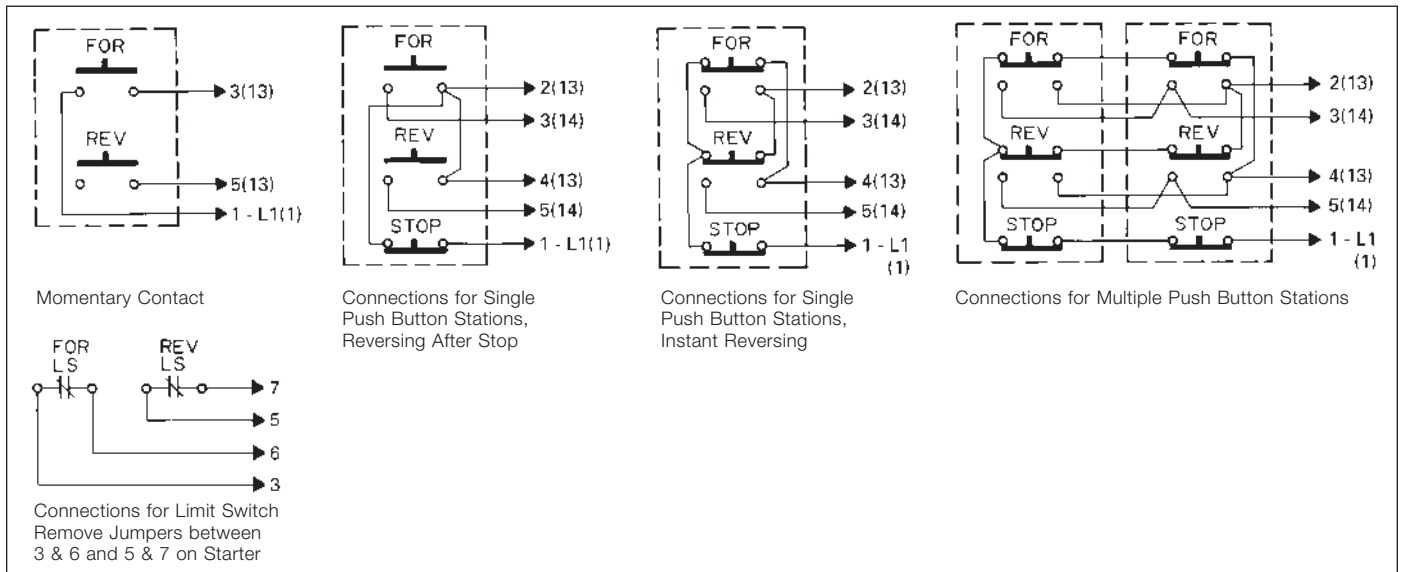
### DC Coil—NEMA Size 0-4



**Non Reversing Pilot Control** Terminal Markings shown in ( ) indicate IEC Style. For separate control voltage source remove Jumper A shown individual in wiring diagrams. Connect separate voltage source to terminal 1 on the pilot device as shown and to the terminal **X2** on the overload relay, or **W(A2)** on the coil if there is no overload.



**Reversing Pilot Control** For Separate control voltage source remove Jumper A shown in individual wiring diagrams. Connect separate voltage source to terminal 1 on the pilot device as shown and to the terminal **X2** on the overload relay, or **W(A2)** on the coil if there is no overload.



# Connection Technology

## Spring loaded terminal technique

### Spring Loaded Terminals

As an alternative to screw-type terminals, many products may be supplied with spring loaded terminals. With this screwless connection technique, the wires are clamped securely against shock and vibration by a spring clamp. Solid, stranded and finely-stranded wires can be connected with or without end sleeves.

Each terminal connection is equipped with two independently operated spring clamps. Each spring can accept one wire. The clamping force of the spring automatically adjusts to the size of the wire and compensates for any deformation of the wire, such as settling

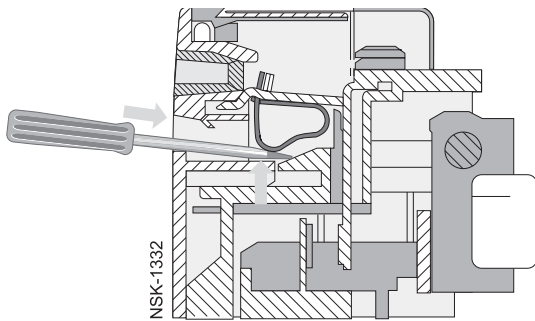
of the strands. The flat clamping face of the spring presses the wire against the current bar without damaging the wire. To prevent stranded or finely-stranded wire from being divided, the end can be tinned or amalgamated using ultrasound.

The terminal is opened by inserting the screwdriver. The wire is then inserted and will remain clamped after the screwdriver is removed (see below). The chromium-nickel steel of the spring clamp provides corrosion-resistant contact of the wire-end in the clamp.

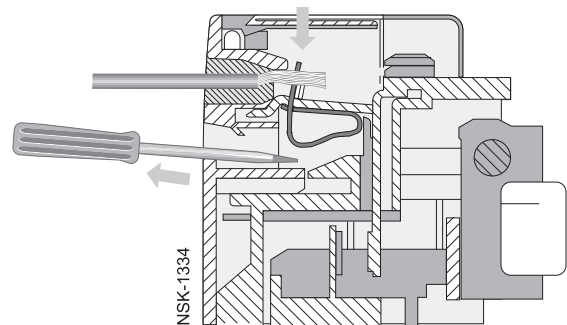
Advantages:

- **Quick:** The connection is made easily without the need to add on wire end sleeves or torque down terminal screws—reducing wiring time
- **Reliable:** The terminal is gas-tight and resistant to shock and vibration—for maximum contact reliability
- **Maintenance-free:** With the spring loaded terminals, there is no need to inspect the connections following transport—eliminating time-consuming and costly inspection

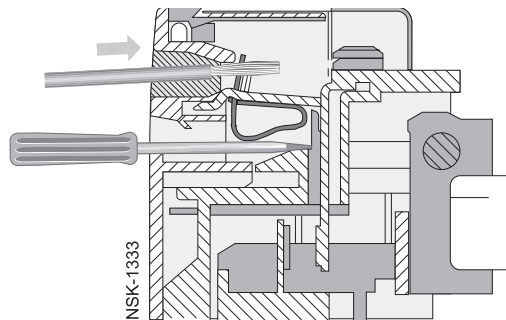
Step 1:  
Insert screwdriver;  
spring opens.



Step 2:  
The screwdriver holds the spring open;  
insert the wire.



Step 3:  
Remove the screwdriver; the spring  
closes and the wire is securely clamped.





## Siemens Canada Ltd. (Seller)

## Siemens standard terms and conditions of sale for products

**1. APPLICABLE TERMS.** This Agreement governs the sale of equipment, components, parts, and materials provided by Siemens ("Products"). Any applicable addenda, these terms, Siemens proposal, price quote, purchase order, or acknowledgement issued by Siemens form the parties' final agreement ("Agreement"). In the event of a conflict between these documents, precedence shall apply in accordance with the order listed in the previous sentence. Siemens' proposal, offer or acceptance is conditioned on Buyer's acceptance of this Agreement. Any additional or conflicting terms in Buyer's request for proposal, specifications, purchase order or any other written or oral communication are not binding on Siemens unless separately signed by Siemens. Siemens' failure to object to Buyer's additional or conflicting terms does not operate as a waiver of any terms contained in this Agreement.

**2. PRICING & PAYMENT.** Prices and payment terms are: (i) as stated in Siemens' proposal, or if none are stated; (ii) Siemens' standard prices in effect when Siemens receives Buyer's purchase order; or if neither (i) or (ii) apply, then Siemens' standard prices in effect when the Products ship.

(a) Payment. Unless stated in Siemens' proposal, all payments are due net thirty (30) days from the invoice date in Canadian Dollars.

(b) Credit Approval. All orders are subject to credit approval by Siemens. Siemens may modify, suspend or withdraw the credit amount or payment terms at any time. If there is doubt as to Buyer's financial condition, Siemens may withhold manufacturing or shipment, require cash payments, or require other satisfactory security. Siemens may recover shipped Products from the carrier pending such assurances.

(c) Installment Shipment. Where Products are delivered in shipments or only part of a shipment fails to comply with this Agreement, the Buyer may only reject the non-compliant portion. Buyer will separately pay for each shipment. If Siemens holds or stores Products for Buyer, it shall do so at Buyer's sole risk and expense.

(d) Taxes, Shipping, Packing, Handling. Unless stated in writing by Siemens, Siemens' prices exclude charges for freight, unloading, storage, insurance, taxes, excises, fees, duties or other government charges related to the Products. Buyer will pay these amounts or reimburse Siemens. If Buyer claims a tax or other exemption or direct payment permit, Buyer will provide a valid exemption certificate or permit and indemnify, defend and hold Siemens harmless from any taxes, costs and penalties arising from same. Siemens' prices include the costs of its standard domestic packing only. Any packing deviation will be charged to Buyer. Increases, changes (including in application), adjustments or surcharges which may be incurred are for Buyer's account.

(e) Late Payments. Late payments shall bear interest at an annual percentage rate of twelve percent (12%) or the highest rate allowed by law, whichever is lower.

(f) Disputed Invoice. If Buyer disputes all or any portion of an invoice, it must first deliver written notice to Siemens of the disputed amount and the basis for the dispute within twenty-one (21) days of receiving the invoice. Failure of Buyer to timely notify Siemens of any dispute constitutes a waiver of Buyer's claim. If Buyer only disputes a portion of the invoice, Buyer must pay the undisputed portion in accordance with Article 2(a). Upon resolution of the dispute, Buyer must pay the invoice or the remainder of the invoice, plus any accrued interest on the late payment.

(g) Suspension/Termination Right. Siemens may suspend work if an undisputed invoice is more than thirty (30) days past due. Siemens may terminate this Agreement if an undisputed invoice is more than sixty (60) days past due. Unless prohibited by law, Siemens may also terminate this Agreement immediately in the event of a material adverse change in Buyer's financial condition including, but not limited to, bankruptcy, insolvency, liquidation or similar financial condition.

**3. DELIVERY; TITLE; RISK OF LOSS.** Products will be delivered F.O.B. Siemens point of shipment with title and risk of loss or damage passing to Buyer at that point. Buyer is responsible for all transportation, insurance and related expenses. The related expenses shall include any taxes, duties or documentation fees. Siemens may make partial shipments. Any shipping, delivery and installation dates are estimated dates only. Siemens is not liable for any loss or expense incurred by Buyer or Buyer's customers if Siemens fails to meet its delivery schedule.

**4. DEFERMENT AND CANCELLATION.** Buyer has no right to defer shipment but may cancel this Agreement on thirty (30) days written notice if Siemens has not already performed. If Buyer cancels this Agreement, it shall pay all cancellation charges including, without limitation: (i) the full price for any finished Product;

(ii) for partially completed product, the portion of the price determined to be due by Siemens based on its percentage of completion of the Product; (iii) reasonable overhead and profit; and (iv) any payments due to subcontractors and/or suppliers for any materials, components or products ordered which cannot be cancelled, refunded, or redirected for other beneficial use.

## 5. TRANSPORTATION AND STORAGE.

(a) When Products are ready for shipment, Siemens will: (i) inform Buyer, and Buyer will then promptly give shipping instructions to Siemens; (ii) determine the method of transportation and shipment routing; and (iii) ship the Products with freight prepaid by normal transportation. If Buyer fails to provide timely shipping instructions, Siemens will ship the Products by normal transportation means to Buyer or to a storage location selected by Siemens. Buyer will pay or reimburse any excess transportation charges for special or expedited transportation.

(b) If Products are placed into storage, delivery occurs and risk of loss transfers to Buyer when the Products are placed on the carrier for shipment to the storage location. If the Products are to be stored in the facility where manufactured, delivery occurs and risk of loss transfers to Buyer when placed in the storage location.

Buyer will pay all Siemens' storage expenses, including but not limited to, preparation for and placement into storage, handling, freight, storage, inspection, preservation, maintenance, taxes and insurance, upon receipt of an invoice(s) from Siemens. When conditions permit and upon payment to Siemens of all amounts due, Buyer must arrange, at its expense, to remove the Products from storage. Buyer bears the risk of loss, damage or destruction to Products in storage.

**6. FORCE MAJEURE / DELAYS.** If Siemens' performance is delayed by any cause beyond its reasonable control (regardless of whether the cause was foreseeable), including without limitation acts of God, strikes, labor shortage or disturbance, fire, accident, war or civil disturbance, delays of carriers, cyber-attacks, terrorist attacks, failure of normal sources of supply, or acts or inaction of government, Siemens' time of performance will be extended by a period equal to the length of the delay plus any consequences of the delay. Siemens will notify Buyer within a reasonable time after becoming aware of any such delay.

**7. BUYER'S REQUIREMENTS.** Siemens' performance is contingent upon Buyer timely fulfilling all of its obligations under this Agreement. These obligations include the Buyer supplying all documents and approvals needed for Siemens to perform, including but not limited to technical information and data, drawing and document approvals, and necessary commercial documentation. Siemens may request a change order for an equitable adjustment in prices and times for performance, as well as for any additional costs or any delay resulting from the failure of Buyer or Buyer's contractors, successors or assigns to meet these obligations.

**8. INDEMNITY.** Siemens and Buyer (each as an "Indemnitor") shall indemnify the other ("Indemnitee") from and against all third party claims alleging bodily injury, death or damage to a third party's tangible property, but only to the extent caused by the Indemnitor's negligent acts or omissions. If the injury or damage is caused by the parties' joint or contributory negligence, the loss and/or expenses shall be borne by each party in proportion to its degree of fault. No part of the Product(s) or Buyer's site is considered third party property.

Indemnitee shall provide the Indemnitor with prompt written notice of any third party claims covered by this Article. Indemnitor has the unrestricted right to select and hire counsel and the exclusive right to conduct the legal defense and/or settle the claim on the Indemnitee's behalf. The Indemnitee shall not make any admission(s) which might be prejudicial to the Indemnitor and shall not enter into a settlement without the express permission of the Indemnitor.

## 9. WARRANTIES.

(a) Warranties. Siemens warrants that: (i) each Product is free from defects in material and workmanship; (ii) each Product materially conforms to Siemens' specifications that are attached to, or expressly incorporated into this Agreement; and (iii) at the time of delivery, Siemens has title to each Product free and clear of liens and encumbrances (collectively, the "Warranties"). The Warranties do not apply to software furnished by Siemens. The sole and exclusive warranties for any software are set forth in the applicable Software License/Warranty Addendum.

(b) Conditions to the Warranties. The Warranties are conditioned on: (i) no repairs, modifications or alterations being made to the Product other than by Siemens or its authorized representatives; (ii) Buyer handling, using, storing, installing, operating and maintaining the Product in compliance with any parameters or instructions in any specifications attached to, or incorporated into this Agreement; (iii) compliance with all generally accepted industry standards; (iv)

## Siemens Canada Ltd. (Seller)

## Siemens standard terms and conditions of sale for products

Buyer discontinuing use of the Product after it has, or should have had, knowledge of any defect; (v) Buyer providing prompt written notice of any warranty claims within the warranty period described below; (vi) at Siemens' discretion, Buyer either removing and shipping the Product or non-conforming part thereof to Siemens, at Buyer's expense, or granting Siemens reasonable access to the Products to assess the warranty claims; (vii) Product not having been subjected to accident (including force majeure), alteration, abuse or misuse; and (viii) Buyer not being in default of any payment obligation.

(c) Exclusions from Warranty Coverage. The Warranties do not apply to any equipment not provided by Siemens under this Agreement.

Any Product that is described as being experimental, developmental, prototype, or pilot is specifically excluded from the Warranties and is provided to Buyer "as is" with no warranties of any kind. Normal wear and tear is excluded, including any expendable items that comprise part of the Product (such as fuses, light bulbs and lamps). Siemens does not warrant or guarantee that any Product will be secure from cyber threats, hacking or similar malicious activity. Products that are networked, connected to the internet, or otherwise connected to computers or other devices must be appropriately protected by Buyer and/or end user against unauthorized access.

**(D) WARRANTY PERIOD.** Buyer must provide written notice of any claims for breach of Warranties by the earlier of twelve (12) months from initial operation of the Product or eighteen (18) months from shipment. Additionally, absent written notice within the warranty period, any use or possession of the Product after expiration of the warranty period is conclusive evidence that the Warranties have been satisfied.

(e) Remedies. Buyer's sole and exclusive remedies for breach of the Warranties are limited, at Siemens' discretion, to repair or replacement of the Product, or its non-conforming parts, within a reasonable time period, or refund of all or part of the purchase price. The warranty on repaired or replaced parts is limited to the remainder of the original warranty period. Unless Siemens agrees otherwise in writing, Buyer will be responsible for any costs associated with: (i) gaining access to the Product; (ii) removal, disassembly, replacement, installation, or reinstallation of any equipment, materials or structures to permit Siemens to perform its warranty obligations; (iii) transportation to and from the Siemens factory or repair facility; and (iv) damage to equipment components or parts resulting in whole or in part from non-compliance by the Buyer with Article 9(b) or from their deteriorated condition. All exchanged Products replaced under this Warranty will become the property of Siemens.

(f) Transferability. The Warranties are only transferable during the warranty period and only to the Product's initial end-user.

(g) THE WARRANTIES IN THIS ARTICLE 9 ARE SIEMENS' SOLE AND EXCLUSIVE WARRANTIES, CONDITIONS AND GUARANTEES AND ARE SUBJECT TO THE LIMITS OF LIABILITY IN ARTICLE 10 BELOW. SIEMENS MAKES NO OTHER WARRANTIES, EXPRESS OR IMPLIED, INCLUDING, WITHOUT LIMITATION, WARRANTIES OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE, COURSE OF DEALING AND USAGE OF TRADE.

**10. LIMITATION OF LIABILITY.** NOTWITHSTANDING ANYTHING IN THIS AGREEMENT TO THE CONTRARY, SIEMENS IS NOT LIABLE, WHETHER BASED IN CONTRACT (INCLUDING FUNDAMENTAL BREACH), WARRANTY, TORT (INCLUDING NEGLIGENCE), STRICT LIABILITY, INDEMNITY OR ANY OTHER LEGAL OR EQUITABLE THEORY, FOR: LOSS OF USE, REVENUE, SAVINGS, PROFIT, INTEREST, GOODWILL OR OPPORTUNITY, COSTS OF CAPITAL, COSTS OF REPLACEMENT OR SUBSTITUTE USE OR PERFORMANCE, LOSS OF INFORMATION AND DATA, LOSS OR DAMAGE TO PROPERTY OR EQUIPMENT, LOSS OF POWER, VOLTAGE IRREGULARITIES OR FREQUENCY FLUCTUATION, CLAIMS ARISING FROM BUYER'S THIRD PARTY CONTRACTS, OR FOR ANY TYPE OF INDIRECT, SPECIAL, LIQUIDATED, PUNITIVE, EXEMPLARY, COLLATERAL, INCIDENTAL OR CONSEQUENTIAL DAMAGES, OR FOR ANY OTHER LOSS OR COST OF A SIMILAR TYPE.

SIEMENS' MAXIMUM LIABILITY UNDER THIS AGREEMENT IS THE ACTUAL PURCHASE PRICE RECEIVED BY SIEMENS FOR THE PRODUCT THAT GAVE RISE TO THE CLAIM.

THE LIMITATIONS OF LIABILITY IN THIS AGREEMENT REPRESENT THE AGREED AND BARGAINED FOR UNDERSTANDING OF THE PARTIES. BUYER AGREES THAT THE EXCLUSIONS AND LIMITATIONS IN THIS ARTICLE 10 WILL PREVAIL OVER ANY CONFLICTING TERMS AND CONDITIONS IN THIS AGREEMENT AND MUST BE GIVEN FULL FORCE AND EFFECT, WHETHER OR NOT ANY OR ALL SUCH REMEDIES ARE DETERMINED TO HAVE FAILED OF THEIR ESSENTIAL PURPOSE. THESE LIMITATIONS OF LIABILITY ARE

EFFECTIVE EVEN IF SIEMENS HAS BEEN ADVISED BY BUYER OF THE POSSIBILITY OF SUCH DAMAGES. THE WAIVERS AND DISCLAIMERS OF LIABILITY, RELEASES FROM LIABILITY AND LIMITATIONS ON LIABILITY EXPRESSED IN THIS ARTICLE 10 EXTEND TO SIEMENS' AFFILIATES, PARTNERS, PRINCIPALS, SHAREHOLDERS, DIRECTORS, OFFICERS, EMPLOYEES, SUPPLIERS, AGENTS, AND SUCCESSORS AND ASSIGNS.

**11. PATENT AND COPYRIGHT INFRINGEMENT.** Siemens will, at its option and expense, defend or settle any suit or proceeding brought against Buyer based on an allegation that any Product or use thereof for its intended purpose constitutes an infringement of any Patent Cooperation Treaty country member's patent or misappropriation of a third party's trade secret or copyright in the country where the Product is delivered by Siemens. Buyer will promptly give Siemens written notice of the suit or proceeding and the authority, information, and assistance needed to defend the claims. Siemens shall have the full and exclusive authority to defend and settle such claim(s) and will pay the damages and costs awarded in any suit or proceeding so defended. Buyer shall not make any admission(s) which might be prejudicial to Siemens and shall not enter into a settlement without Siemens' consent. Siemens is not responsible for any settlement made without its prior written consent. If the Product, or any part thereof, as a result of any suit or proceeding so defended is held to constitute infringement or its use by Buyer is enjoined, Siemens will, at its option and expense, either: (i) procure for Buyer the right to continue using said Product; (ii) replace it with substantially equivalent non-infringing Product; or (iii) modify the Product so it is non-infringing.

Siemens will have no duty or obligation under this Article 11 if the Product is: (i) supplied according to Buyer's design or instructions and compliance therewith has caused Siemens to deviate from its normal course of performance; (ii) modified by Buyer or its contractors after delivery; or (iii) combined by Buyer or its contractors with devices, methods, systems or processes not furnished hereunder and by reason of said design, instruction, modification, or combination a suit is brought against Buyer. In addition, if by reason of such design, instruction, modification or combination, a suit or proceeding is brought against Siemens, Buyer must protect Siemens in the same manner and to the same extent that Siemens has agreed to protect Buyer under this Article 11.

THIS ARTICLE 11 IS AN EXCLUSIVE STATEMENT OF SIEMENS' DUTIES AND BUYER'S REMEDIES RELATING TO PATENTS, TRADE SECRETS AND COPYRIGHTS, AND DIRECT OR CONTRIBUTORY INFRINGEMENT THEREOF.

## 12. CONFIDENTIALITY.

(a) Both during and after the term of this Agreement, the parties will treat as confidential all information obtained from the disclosing party and all information compiled or generated by the disclosing party under this Agreement for the receiving party, including but not limited to business information, manufacturing information, technical data, drawings, flow charts, program listings, software code, and other software, plans and projections. Neither party may disclose or refer to the work to be performed under this Agreement in any manner that identifies the other party without advance written permission. However, Siemens has the right to share confidential information with its affiliates and subcontractors, provided those recipients are subject to the same confidentiality obligations set forth herein.

(b) Nothing in this Agreement requires a party to treat as confidential any information which: (i) is or becomes generally known to the public, without the fault of the receiving party; (ii) is disclosed to the receiving party, without obligation of confidentiality, by a third party having the right to make such disclosure; (iii) was previously known to the receiving party, without obligation of confidentiality, which fact can be demonstrated by means of documents which are in the possession of the receiving party upon the date of this Agreement; (iv) was independently developed by receiving party or its representatives, as evidenced by written records, without the use of discloser's confidential information; or (v) is required to be disclosed by law, except to the extent eligible for special treatment under an appropriate protective order, provided that the party required to disclose by law will promptly advise the originating party of any requirement to make such disclosure to allow the originating party the opportunity to obtain a protective order and assist the originating party in so doing.

(c) It is Siemens' policy not to unlawfully or improperly receive or use confidential information, including trade secrets, belonging to others. This policy precludes Siemens from obtaining, directly or indirectly from any employee, contractor, or other individual rendering services to Siemens confidential information of a prior employer, client or any other person which such employee, contractor, or individual is under an obligation not to disclose. Buyer agrees to abide by this policy.

## Siemens Canada Ltd. (Seller)

## Siemens standard terms and conditions of sale for products

**13. COMPLIANCE WITH LAWS.** The parties agree to comply with all applicable laws and regulations, including but not limited to those relating to the manufacture, purchase, resale, exportation, transfer, assignment or use of the Products.

**14. CHANGES IN WORK.** No change will be made to the scope of work unless Buyer and Siemens agree in writing to the change and any resulting price, schedule or other contractual modifications. If any change to any law, rule, regulation, order, code, standard or requirement impacts Siemens' obligations or performance under this Agreement, Siemens may request a change order for an equitable adjustment in the price and time of performance.

**15. NON-WAIVER.** Any waiver by a party of strict compliance with this Agreement must be in writing, and any failure by the parties to require strict compliance in one instance will not waive its right to insist on strict compliance thereafter.

**16. MODIFICATION OF TERMS.** This Agreement may only be modified by a written instrument signed by authorized representatives of both parties.

**17. ASSIGNMENT.** Neither party may assign all or part of this Agreement, or any rights or obligations under this Agreement, without the prior written consent of the other; but either party may assign its rights and obligations, without recourse or consent, to any parent, wholly owned subsidiary, or affiliate or affiliate's successor organization (whether as a result of reorganization, restructuring or sale of substantially all of a party's assets). However, Buyer shall not assign this Agreement to: a competitor of Siemens; an entity in litigation with Siemens; or an entity lacking the financial capability to satisfy Buyer's obligations. Any assignee expressly assumes the performance of any obligation assigned. Siemens may grant a security interest in this Agreement and/or assign proceeds of this Agreement without Buyer's consent.

**18. APPLICABLE LAW AND JURISDICTION.** This Agreement is governed by and construed in accordance with the laws of the Province of Ontario and the federal laws of Canada applicable therein, without regard to its conflict of laws principles. The application of the United Nations Convention on Contracts for the International Sale of Goods is excluded. Each party agrees that claims and disputes arising out of this Agreement must be decided exclusively in a federal or provincial court of competent jurisdiction located in a province in which either Buyer or Siemens maintains its principal place of business. Each party submits to the personal jurisdiction of such courts for the purpose of litigating any claims or disputes.

**19. SEVERABILITY.** If any provision of this Agreement is held invalid, illegal or unenforceable, the remaining provisions will not in any way be affected or impaired. A court may modify the invalid, illegal or unenforceable provision to reflect, as closely as possible, the parties' original intent.

**20. EXPORT / IMPORT COMPLIANCE.** Buyer acknowledges that Siemens is required to comply with applicable export / import laws and regulations relating to the sale, export, import, transfer, assignment, disposal and use of the Products, including any export / import license requirements. Buyer agrees that Products will not at any time directly or indirectly be used, exported, imported, sold, transferred, assigned or otherwise disposed of in a manner which will result in non-compliance with any applicable Canadian or, to the extent permissible under Canadian law, U.S. export / import laws and regulations. Siemens' continuing performance hereunder is conditioned on compliance with such export / import laws and regulations at all times.

**21. PRODUCT RETURNS.** Prior to the return of any Product to Siemens, Buyer must identify the Product or portion thereof and obtain written authorization and shipping instructions from Siemens. Siemens has the right, in its sole discretion, to permit or reject any such return. Siemens' authorization to return any Product to Siemens does not relieve Buyer of its obligation to pay for such Product. Upon receipt, inspection, and acceptance of the Product by Siemens, Siemens will issue a credit memo to Buyer, less applicable re-stocking fees. Siemens reserves the right to reject any hazardous material.

**22. NUCLEAR.** Unless expressly authorized in writing by Siemens, the Products must not be used in or in connection with a nuclear facility or application. If Buyer uses any Product in connection with any nuclear facility or activity, it does so at its own risk and Buyer will indemnify, defend and hold Siemens harmless, and waives and will require its insurers to waive all right of recovery against Siemens for any damage, loss, destruction, injury or death resulting from a "nuclear incident," as defined in the Nuclear Liability and Compensation Act, as amended, whether or not due to Siemens' negligence. Siemens' consent to Buyer's use of the Product in connection with any nuclear facility or application will be subject to additional terms and conditions that Siemens deems necessary to protect its interests.

**23. SURVIVAL.** The articles titled "Patent and Copyright Infringement," "Limitation of Liability," "Confidentiality," "Delivery; Title; Risk of Loss," "Export / Import Compliance," and "Nuclear" survive termination, expiration or cancellation of this Agreement.