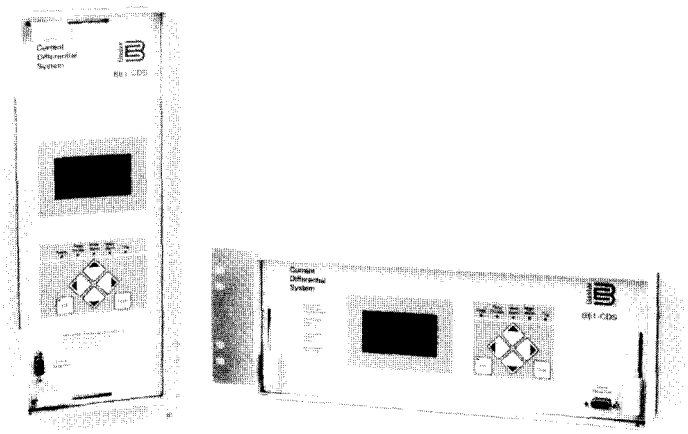


BE1-CDS CURRENT DIFFERENTIAL PROTECTION SYSTEMS

The **BE1-CDS Current Differential Protection Systems** are multifunction, numerical relays that provide percentage restrained differential protection along with overcurrent, breaker failure, control, metering, monitoring, and alarm functions in an integrated system. Available in 3 phase, 2 restraint (CDS220), and 3 phase, 3 restraint (CDS230).

ADVANTAGES

- All versions include harmonic restraint as well as phase shift and tap compensation for use in transformer applications. Detailed current check report provides record of proper CT connections.
- Includes frequency compensation for high accuracy in generator and motor differential applications.
- BESTlogic provides the user with complete flexibility in configuring a protection and control system. User programmable variable and switch names make the CDS relays completely self-documenting.
- Each CT circuit is low burden and isolated to allow improving zones of protection with fewer costly CTs.
- Optional programmable LCD display allows the relay to replace local indication and control functions such as panel metering, alarm annunciation, and control switches.
- Three independent communications ports with protocol support allow integration with distributed control systems.
- The CDS220 is available in horizontal and vertical configurations to provide cost savings in any installation. The CDS220 is fully drawout and fits cutout, drilling, and behind-panel projection dimensions for common Basler Electric, GE, and Westinghouse differential relays.

WINDOWS® SOFTWARE

Interface for setting and communicating with Basler protection products. Request BESTCOMS for BE1-CDS.

ADDITIONAL INFORMATION

INSTRUCTION MANUAL
Request publication 9313900990

TIMING CURVES
Request publication 9252000999

MODBUS™ INSTRUCTION MANUAL
Request publication 9313900991

DNP® 3.0 INSTRUCTION MANUAL
Request publication 9313900992

Basler Electric
P. O. BOX 269 HIGHLAND, ILLINOIS, U.S.A. 62249 PHONE 618-654-2341 FAX 618-654-2351

FEATURES

PROTECTION
- Percentage Restrained Current Differential with harmonic restraint: 87
- Percent Restraint characteristic can be percent of maximum or percent of average through current.
- 2nd Harmonic sharing feature enhances security to transformer inrush.
- Optional Restricted Ground Fault: 87ND (requires optional independent ground input)
- Phase, Neutral, and Negative Sequence Instantaneous Overcurrent elements with settable time delay: 50TP, 150TP, 250TP, 50TN, 150TN, 250TN, 50TQ, 150TQ, 250TQ
- Phase, Neutral, Ground, and Negative Sequence Time Overcurrent elements: 51P, 151P, 251P, 51N, 151N, 251N, 51Q, 151Q, 251Q
- All U.S. and IEC timing curves plus user programmable curve
- Responds to fundamental component of the power system currents
- Minimizes transient overreach and overtravel on overcurrent elements
- Breaker Failure protection function: BF
- Lockout function (Available in CDS230): 86, 186
- Two general purpose logic timers: 62, 162
- Programmable logic using BESTlogic
- Four protection settings groups with external or automatic (cold load pickup, and/or dynamic) selection modes

CONTROL
- Virtual Breaker Control Switch—controllable from both HMI and com. ports: 101
- Eight virtual selector switches—controllable from both HMI and com. ports: 43, 143, 243, 343, 443, 543, 643, 743

INSTRUMENTATION
- Real time A, B, C phase, neutral and negative sequence currents for each 3 phase CT input circuit
- Real time ground current for optional independent ground input
- Real time tap and phase compensated restraint and operate currents for each differential element
- Real time 2nd and 5th harmonic restraint currents for each differential element
- 1% meter accuracy down to 10% nominal current

REPORTS
- Current Demands for phase, neutral and negative sequence for designated CT input — magnitudes and time stamps are recorded for today's peak, yesterday's peak, and peak since reset (calculation settable for thermal, sliding block average, and block average)
- Optional 4000 point log of demand reading
- Breaker operations counter and contact wear duty
- Transformer through-fault duty statistics

FAULT RECORDING
- 255 event sequence of events report with I/O and alarm sub-reports
- Fault Reporting; 1 or 2 oscillography records per fault report
- Fault summary reports; two most recent Fault Summary Records saved to non-volatile memory
- Total number of fault and oscillography records settable from 6 to 16
- Total of 240 cycles oscillography memory @ 24 samples/cycle
- COMTRADE format
- SER and Fault reporting doubled when Load Profile option is selected

COMMUNICATIONS PORTS
- Three independent general purpose communication ports
  - Front RS-232 ASCII communications
  - Rear RS-232 ASCII communications
  - Rear RS-485 ASCII, Modbus®, or other common protocols
- IRIG-B time sync (unmodulated)

SELF TEST AND ALARM FUNCTIONS
- Relay Fail, major alarm and minor alarm LEDs, and fail-safe alarm output contact
- Extensive internal diagnostics monitor all internal functions of the relay
- More than 20 additional alarm points — programmable for major or minor priority, including:
  - Phase demand overload alarm
  - Neutral and negative sequence unbalance demand alarms
  - Three breaker alarm points—programmable for slow trip, interruption duty threshold, or operations counter
  - Three transformer alarm points—programmable for through fault operations or accumulated through fault duty

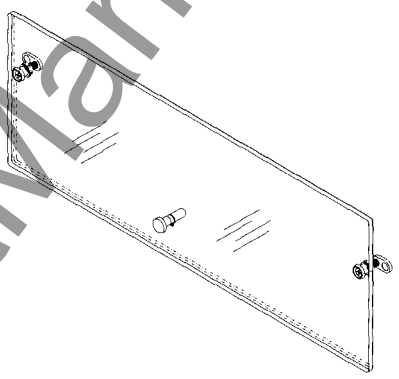
SELF TEST AND ALARM FUNCTIONS
- Transformer differential alarm monitors Iop/Ires characteristics to alarm if nearing trip condition on load. Diagnostics provide indication of polarity, phase shift and tap mismatch conditions

FEATURES, continued

SELF TEST AND ALARM FUNCTIONS, continued
- Trip circuit voltage and continuity monitor
- Programmable logic alarms

PROGRAMMABLE I/O
- All current based functions are individually programmable for which CT input circuit is monitored
- Eight programmable contact sensing inputs
- Six programmable outputs and one dedicated programmable alarm output
- Outputs 1 and 6 are high speed (1/4 cycle nominal)
- Output 6 is Form C

HARDWARE FEATURES
- CDS220
  - MX Vert: M1, M2/FT31, FT32 size, fully drawout
  - MX Horiz: panel or 19" rack mount, fully drawout
- CDS230
  - 19" rack mount, non-drawout
- Active CT technology for low burden and increased dynamic range
- Flash Memory for upgrading embedded programming without changing chips
- Optional HMI with Graphic LCD display
- Optional cover (see below)



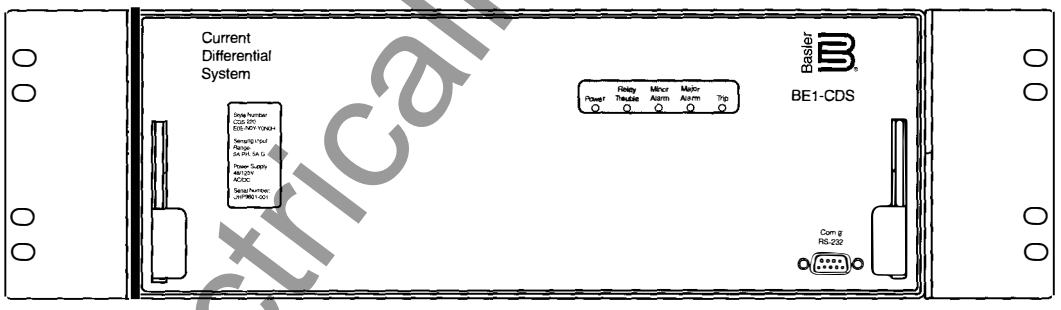


Figure 1 - Standard Front Panel
CDS220 Horizontal Rack Mount version shown

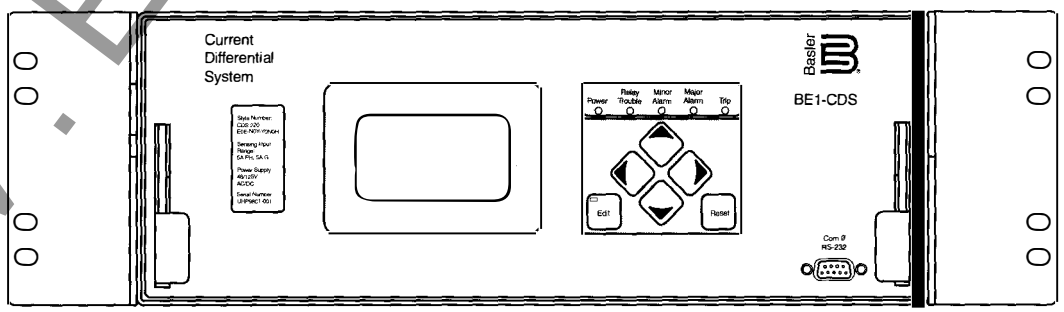


Figure 2 - Optional Advanced HMI (Human Machine Interface)
CDS220 Horizontal Rack Mount version shown

APPLICATIONS

The BE1-CDS Current Differential Protection System provides percentage restrained differential protection along with multiple overcurrent elements and is intended for use in any low impedance current differential protection application including transformer, generator, motor, and bus protection. Its unique capabilities make it ideally suited for applications with the following requirements:

- Applications that require low burden to extend the linear range of CTs.
- Applications where dedicated CTs for the differential are not available. Unlike traditional differential relays, dedicated CT circuits are not required because each CT input is isolated from the others and phase shift compensation can be accomplished internally.
- Applications that require high accuracy across a wide frequency range such as for motor, generator, and generator step-up transformer protection or in cogeneration facilities.
- Applications that require the flexibility provided by wide settings ranges, multiple setting groups, and multiple coordination curves in one unit.
- Applications that require the economy and space savings provided by a multifunction, multiphase unit. This one unit can provide all the protection as well as local and remote indication, metering, and control required on a typical circuit.
- Applications that require harmonic restraint to aid security for the differential.
- Applications that require communication capability and protocol support.
- Applications where the optional case configurations facilitate modernizing protection and control systems in existing substations.
- Applications where the capabilities of a digital multifunction relay are required, yet drawout construction is also desirable.
- Applications where bus protection is provided by a high speed overcurrent blocking scheme on the transformer bus mains instead of dedicated bus differential circuit.
- Applications where the capabilities of intelligent electronic devices (IEDs) are used to decrease relay and equipment maintenance costs.

FUNCTIONAL DESCRIPTION

The BE1-CDS relays use advanced digital signal processing to enhance differential protection. Numerical technology allows this multifunction relay to provide unprecedented flexibility, security, and performance in differential protection.

Numerical design, with **16 bit A/D** precision, **frequency tracking, digital filters**, and **active CTs** provides high accuracy and wide dynamic range, resulting in wide settings ranges. The differential protection element can even handle mismatch between current inputs with a **tap adjust range of 10:1**.

The percentage restrained differential element can be set to respond to either percent of **maximum** through current or percent of **average** through current. Maximum restraint is recommended, because it uses information from the best-performing CT to restrain the differential element. The flexibility provided by numerical design allows us to also offer average restraint to emulate the operating characteristic of common electromechanical differential relays.

To improve security from misoperation on false differential caused by CT saturation, the differential protection element includes a **transient monitor** that monitors the restraint and operate currents to detect false differential current caused by CT saturation. The relay then modifies its response to enhance security under this condition.

To improve security from misoperation during inrush in transformer protection applications, the percentage restrained differential element includes **2nd harmonic restraint**. Since the 2nd harmonic component of inrush current may not be equally shared on all three phases, misoperation can occur on a phase with low 2nd harmonic content. Our unique method of **2nd harmonic sharing** improves security by allowing the harmonic restraint elements to respond to the ratio of operate current to the sum of harmonic current measured on all three phases. This is superior to other methods of cross blocking, since each phase element operates independently in its comparison of operating current to harmonic current. Thus, security is en-

FUNCTIONAL DESCRIPTION, continued

hanced without sacrificing dependability, because a faulted phase will not be restrained by inrush on unfaulted phases.

To further enhance security from false tripping on inrush, the operating characteristic responds only to the fundamental component of this highly distorted current – reducing sensitivity to inrush current, yet allowing improved sensitivity to power system faults.

Advanced digital signal processing also provides flexibility for application of differential relays with simpler CT connections. **Phase shift** and **zero sequence compensation** can be done internally in the relay, eliminating the need for special CT connections. Connecting CTs in wye simplifies CT circuit checkout and reduces burden on the CT circuit itself, reducing the likelihood of misoperation caused by CT saturation. The internal zero sequence compensation can even accommodate additional ground sources such as zig-zag grounding banks within the zone of protection.

With **all CT inputs isolated** and **low burden**, and the ability to connect all CTs in wye, the need for dedicated CTs for differential protection is eliminated, allowing zones of protection to be improved with fewer CTs required. However, the BE1-CDS can also accept traditional differential CT connections to make retrofit and modernization projects simple.

BESTlogic

BESTlogic programmable logic provides the user with high flexibility in configuring a protection and control system.

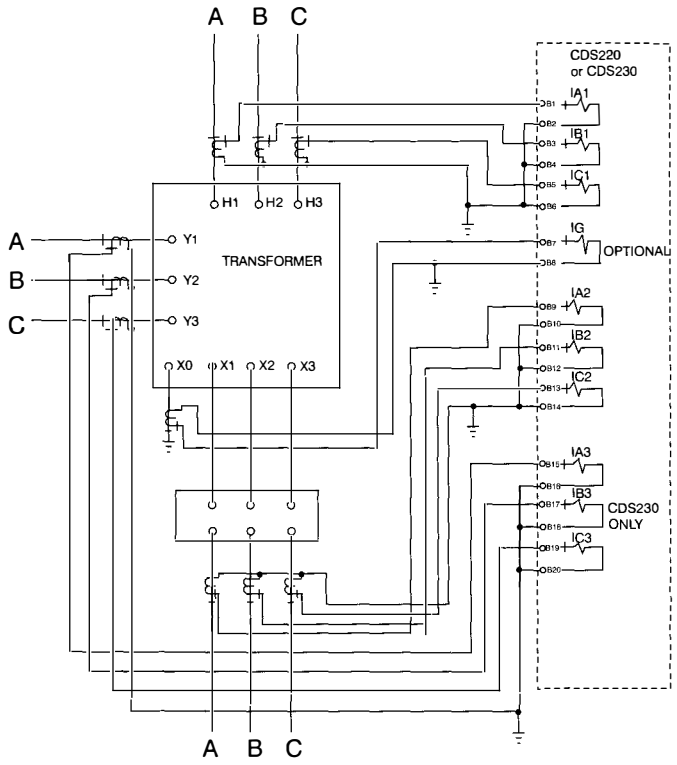
Each of the protection and control functions in the BE1-CDS is implemented as an independent function block that is equivalent to its single function, discrete device counterpart. Each independent function block has all the inputs and outputs that the discrete component counterpart might have. Figures 6A and 6B show each of the independent function blocks available for use in the BE1-CDS. Programming BESTlogic is equivalent to choosing the devices required by your protection and control scheme and drawing schematic diagrams to connect the inputs and outputs to obtain the desired operational logic.

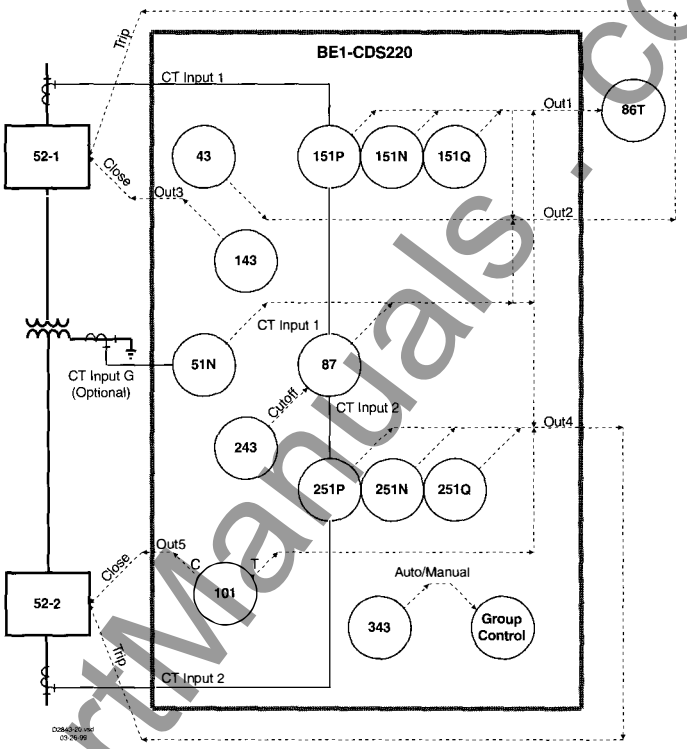
The BE1-CDS relay can store, as user settings, one user programmable, custom logic scheme. To save you time, several preprogrammed logic schemes have also been provided. Any of the preprogrammed schemes may be copied into the logic settings without making any additional BESTlogic settings.

BESTlogic provides the protection engineer with the flexibility to set up this powerful multifunction system with the same freedom that was once enjoyed with single function, discrete devices. It is no longer necessary to compromise your standard protection and operating practices to deal with the limitations in programmability of previous multifunction devices.

Figure 5 shows rear panel connections.

FUNCTIONAL DESCRIPTION, continued





* Based on preprogrammed logic TX-W-CTL. Not all available protection and control functions are shown.

Figure 3 - Typical AC Connections

Figure 4 - Typical Application Single Line

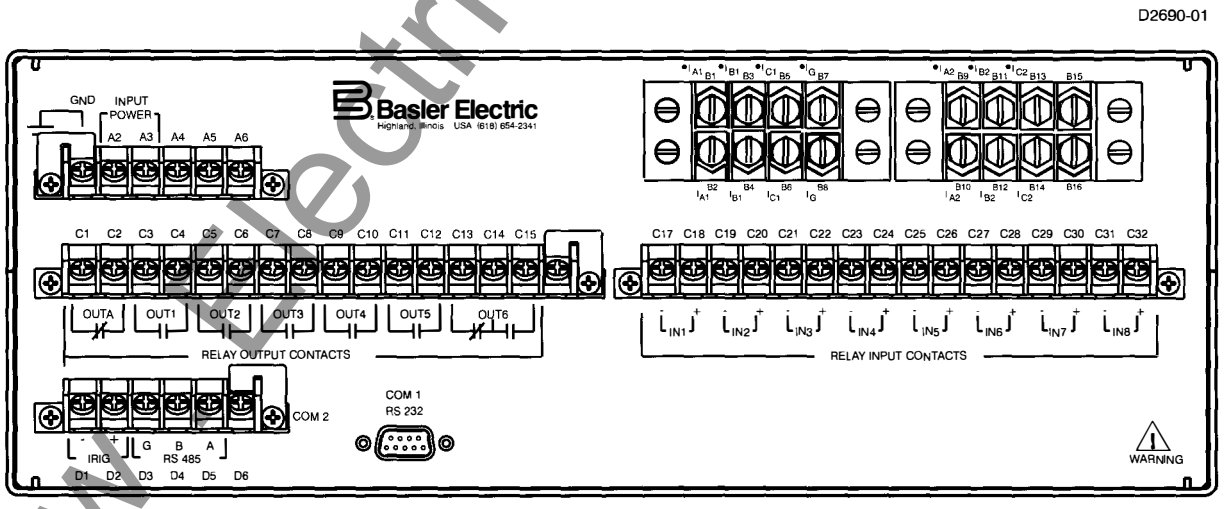


Figure 5 - CDS220 Rear Panel Connections

GENERAL SPECIFICATIONS

5 Amp CURRENT INPUTS

Continuous:	20 Amps
One Sec. Rating:	400 Amps
Saturation limit:	150 Amps
Burden:	<10 milliohms @ 5A

1 Amp CURRENT INPUTS

Continuous:	4 Amps
One Sec. rating:	250 Amps
Saturation limit:	30 Amps
Burden:	<22 milliohms @ 1A

A/D CONVERTERS

Sampling Rate:	144/cycle*
Output of digital filter:	24/cycle*

* Adjusted to input frequency 40-63Hz

POWER SUPPLY

Option L:	DC Range 17 - 32V
Option Y:	DC Range 35 - 150V AC Range 55 - 135V
Option Z:	DC Range 90 - 300V AC Range 90 - 270V
Burden:	16 Watts

TRIP CONTACTS

Make and carry:	30A (0.2sec)
Continuous:	7A
Break:	0.3A DC (L/R=0.04)

CONTROL INPUTS

Wetting voltage range:	Same as power supply option
PS Option L:	Burden 16kohm Nominal Turnon 16Vdc
PS Option Y:	Low setting burden 37.5Kohm Nominal Turnon 33Vdc High setting burden 95Kohm Nominal Turnon 83Vdc
PS Option Z:	Low setting burden 95Kohm Nominal Turnon 83Vdc High setting burden 190Kohm Nominal Turnon165Vdc

COMMUNICATION PORTS

Response Time:	<100mSec for metering and control functions
Baud Rate:	300 - 19200

500Vdc in accordance with UL-508
2000Vac hipot

ELECTRICAL ENVIRONMENT

- IEEE C37.90-1989 Standard for Relays and Relay Systems Associated with Electric Power Apparatus
- IEC 255-5 Insulation Test for Electrical Relays Impulse and Dielectric Strength (2000Vac at 50/60Hz)
- IEEE C37.90.1-1989 Standard Surge Withstand Capability Tests for Relays and Relay Systems Associated with Electric Power Apparatus
- IEC 255-22-1 1MHz Burst Disturbance Tests for Electrical Disturbance Tests for Measuring Relays and Protection Equipment
- EN 61000-4-4 Electrical Fast Transient/Burst Immunity Test
- EN 61000-4-3 Radiated, Radio-frequency, Electromagnetic Field Immunity Test
- Type tested using a 5-watt, hand-held transceiver in the ranges of 144 and 440MHz with the antenna placed within 6 inches of the relay.
- IEEE C37.90.3 (Jan. 01) Draft Standard Electrostatic Discharge Tests for Protective Relays
- EN 61000-4-2 Electrostatic Discharge Immunity Test

MECHANICAL ENVIRONMENT

- Operating temperature range: -40°C to 70°C* (-40°F to 158°F)
  *LCD Display is inoperative below -20°C.
- Storage temperature range: -40°C to 70°C (-40°F to 158°F)
- Humidity: Qualified to IEC 68-2-38, 1st Edition 1974, Basic Environmental Test Procedures, Part 2: Test Z/AD: Composite Temperature Humidity Cyclic Test
- Qualified to IEC 255-21-1 (Class 1) Vibration Tests for Electrical Relays
- Qualified to IEC 255-22-2 (Class 1) Shock and Bump Tests for Electrical Relays

CERTIFICATIONS

UL Recognized, File E97033
CSA Certified, File LR23131
DNP 3.0 IED Certified, Subset Level 2, 6/20/00, by SUBNET Solutions, Inc.

CASE SIZE (Vertical unit)

5.40"W x 14.63"H x 8.70"D behind panel
(5.40"W x 14.63"H x 7.70"D alternate mounting)

CASE SIZE (Horizontal unit)

14.63"W x 5.40"H x 8.70"D behind panel
(14.63"W x 5.40"H x 7.70"D alternate mounting)

CASE SIZE (Rack mount)

14.63"W x 5.40"H x 8.70"D without flanges

SHIPPING WEIGHT

Approx. 16.5 pounds

WARRANTY

7 years

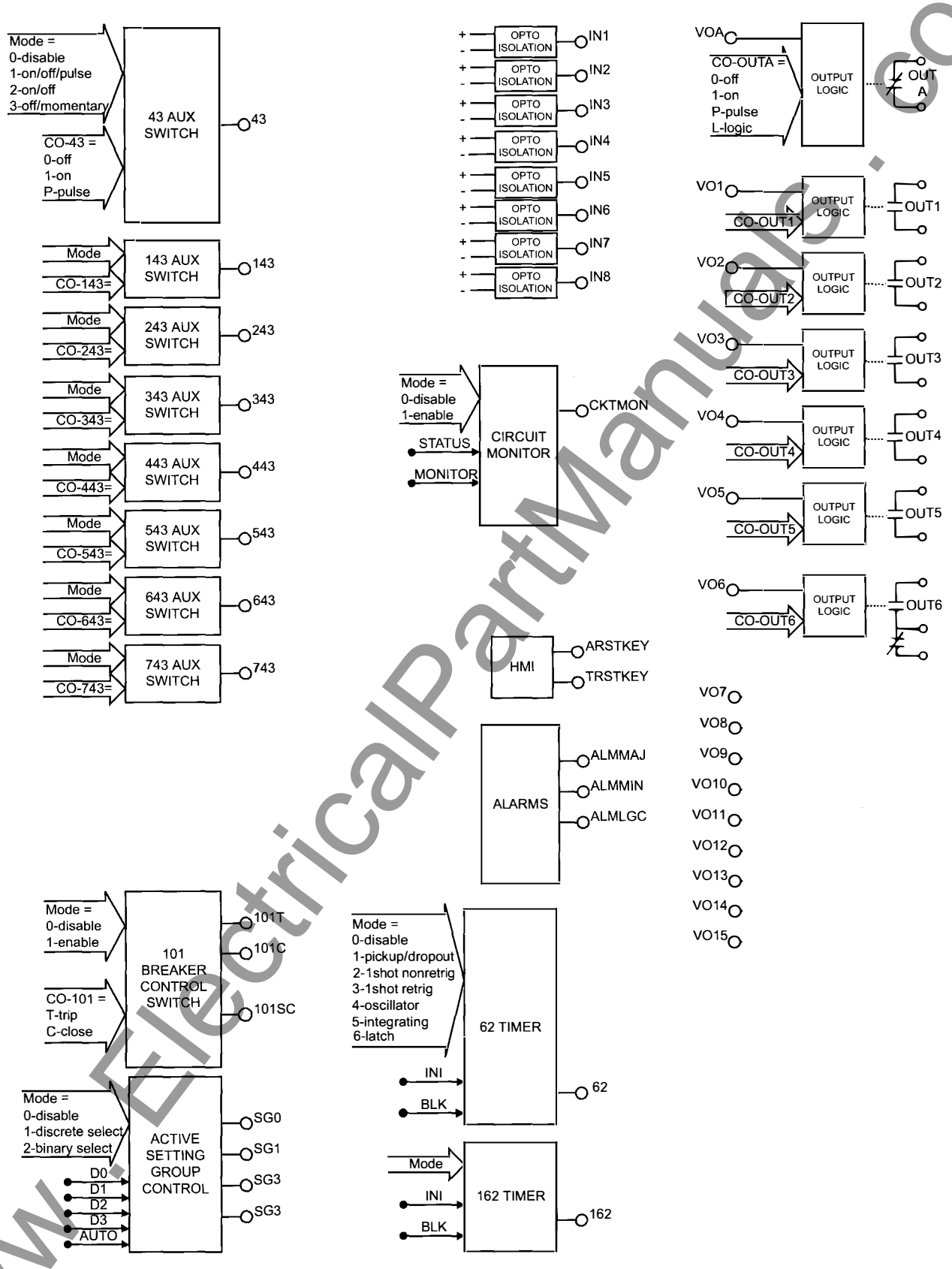
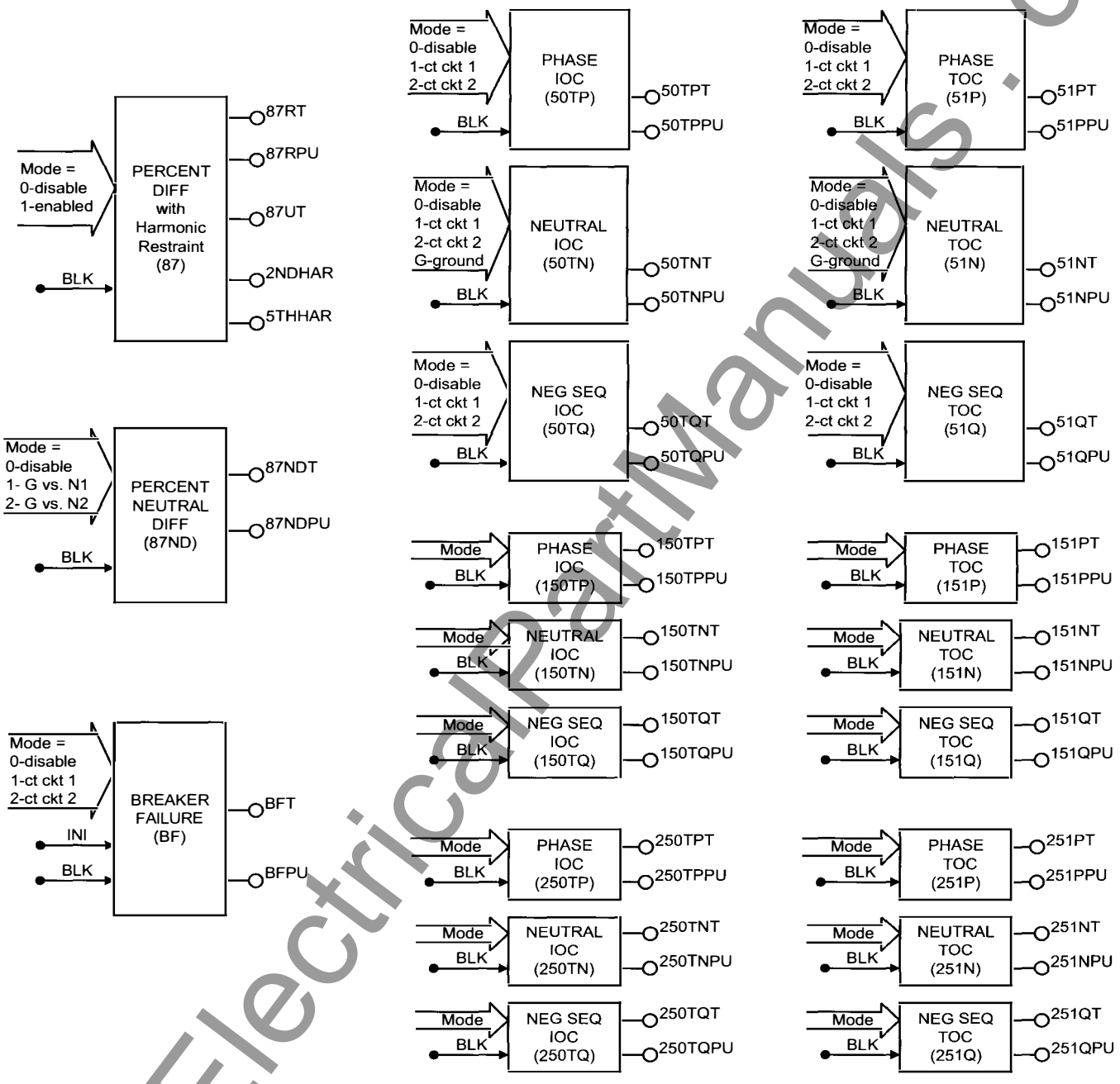


Figure 6A - CDS220 and CDS230 BESTlogic Function Blocks



NOTE: Modes shown are for the CDS220. The following additional modes are available for the CDS230:

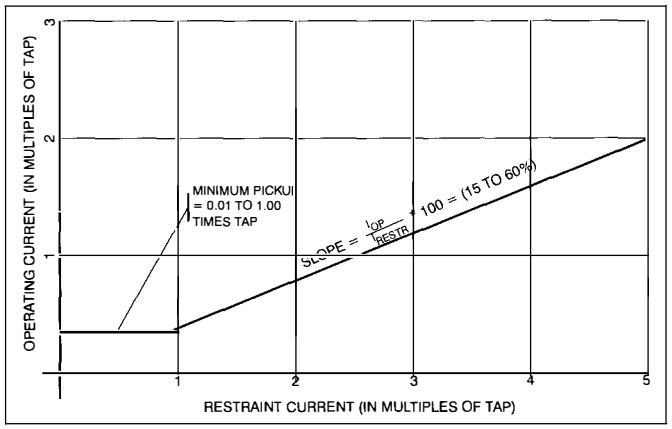
50/51s	87
mode 3 = ct ckt 3	Any combination of inputs can be
mode c = combo	included in the differential zone.

where combo is the vector sum of ct ckt 1 and 2, ct ckt 1 and 3 or ct ckt 2 and 3.

Figure 6B - CDS220 and CDS230 BESTlogic Function Blocks

PERFORMANCE SPECIFICATIONS

PERCENTAGE RESTRAINED DIFFERENTIAL (87R)



Tap:	5A CT	2.0-20 Amps
	1A CT	0.4-4.0 Amps
Minimum PU	0.10-1.00 times tap	
Restraint Method	Maximum Average	
Restraint Slope:	15-60%, off	
2nd & 5th Harmonic	5-75%, off	
Response Time:	<2 cycles @ 5 x pickup <3 cycles @ 1.5 x pickup	

UNRESTRAINED DIFFERENTIAL (87U)

Unrestrained PU	1-21 times Tap up to 150A Symmetrical
Response Time:	<1 cycle @ 5 x pickup <2 cycles @ 1.5 x pickup

RESTRICTED EARTH FAULT GROUND DIFFERENTIAL (87ND)

Tap:	5A CT	2.0-20 Amps
	1A CT	0.4-4.0 Amps
Minimum PU	0.10-1.00 times tap	
Restraint Slope	15-60%	

Curve Type	Constants					
	A	B	C	N	K	R
S1	0.2663	0.03393	1.000	1.2969	0.028	0.5000
S2	0.0286	0.02080	1.000	0.9844	0.028	0.0940
L1	5.6143	2.18592	1.000	1.000	0.028	15.750
L2	2.3955	0.00000	1.000	0.3125	0.028	7.8001
D	0.4797	0.21359	1.000	1.5625	0.028	0.8750
M	0.3022	0.12840	1.000	0.5000	0.028	1.7500
I1	8.9341	0.17966	1.000	2.0938	0.028	9.0000
I2	0.2747	0.1042	1.000	0.4375	0.028	0.8868
V1	5.4678	0.10814	1.000	2.0469	0.028	5.5000
V2	4.4309	0.0991	1.000	1.9531	0.028	5.8231
E1	7.7624	0.02758	1.000	2.0938	0.028	7.7500
E2	4.9883	0.0129	1.000	2.0469	0.028	4.7742
A	0.01414	0.00000	1.000	0.0200	0.028	2.0000
B	1.4636	0.00000	1.000	1.0469	0.028	3.2500
C	8.2506	0.00000	1.000	2.0469	0.028	8.0000
G	12.1212	0.00000	1.000	1.000	0.028	29.000
F	0.0000	1.00000	0.000	0.0000	0.028	1.0000
P	0 to 600	0 to 25	0 to 1	.5 to 2.5	0.028	0 to 30

S1, S2 = CO Short Inv, IAC Short Inv
L1, L2 = CO Long Inv, IAC Long Inv
D = CO Definite Time
M = CO Moderately Inverse
I1, I2 = CO Inverse, IAC Inverse
V1, V2 = CO Very Inv, IAC Very Inv
E1, E2 = CO Ext Inverse, IAC Ext. Inverse
A = IEC Standard Inverse
B = IEC Very Inverse
C = IEC Extremely Inverse
G = IEC Long Time Inverse
F = Fixed Time
P = Programmable

INSTANTANEOUS OVERCURRENT WITH SETTABLE DELAY (50TP, 150TP, 250TP, 50TN, 150TN, 250TN, 50TQ, 150TQ, 250TQ)

Pickup:	5A CT	0.5-150.0 Amps
	1A CT	0.1-30.0 Amps
Pickup Time:		1¼ cyc @ 5 times PU 2 cyc @ 1.5 times PU 4 cyc @ 1.05 times PU
Delay Time	0.00-60.0 Sec	
PU time with TD=0.000 Sec		1¼ cyc for P, N, & G @ 5 x PU 2¼ cyc for Q @ 5 x PU
Delay time:	0.000 - 60 sec	
Time Accuracy:	±0.5% or ±¼ cyc for P & N ±0.5% or ±1 cyc for Q	

TIME OVERCURRENT (51P, 151P, 251P, 51N, 151N, 251N, 51Q, 151Q, 251Q)

Pickup:	5A CT	0.5-16.0 Amps
	1A CT	0.1-3.2 Amps
Time Dial:	TD=K=0-99 for 46 curve TD=0.0 - 9.9 for all other curves	
Time-Current Characteristics:		Same curves as 51 elements

PERFORMANCE SPECIFICATIONS, continued

BREAKER FAILURE (BF)

Time:		50 - 999mSec
Dropout:	5A CT	0.5A
	1A CT	0.1A
Time Accuracy:		±0.5% or +1¼ cyc / -½ cyc

GENERAL PURPOSE LOGIC TIMERS (62, 162, 262, 362)

Mode:	PU/DO 1 Shot, Non-Retrig. 1 Shot, Retrig. Integrating Latch
T1 and T2 Delay TIme:	0.000 - 9999 Sec.
Time Accuracy:	±0.5% or ±½ cyc

CURRENT PICKUP ACCURACY (All 50 and 51)

Phase and Ground:	5A	2% or 50mA
	1A	2% or 10mA
Neutral and Negative	5A	3% or 75mA
Sequence:	1A	3% or 75mA

SETTING GROUPS

Setting Groups:	4
Control Modes:	Automatic: CLP; Dynamic load or unbalance External: Discrete input logic Binary: Input Logic

METERING

Current Range:	5A	0.5 to 15.0
	1A	0.1 to 3.0
Current Accuracy:		±1%
Frequency:		40 - 63Hz

DEMANDS (IA, IB, IC, IN, IQ)

Demand Interval:	1 - 60 min.
Demand Mode:	Thermal Sliding Block Average Block Average

BREAKER MONITORING

Duty Mode:	I or I^2
Duty Alarm Range:	0 - to 100%
Op Counter Alarm Range:	0 - 99999
Trip Time Alarm Range:	20 - 1000mSec

TRANSFORMER MONITORING

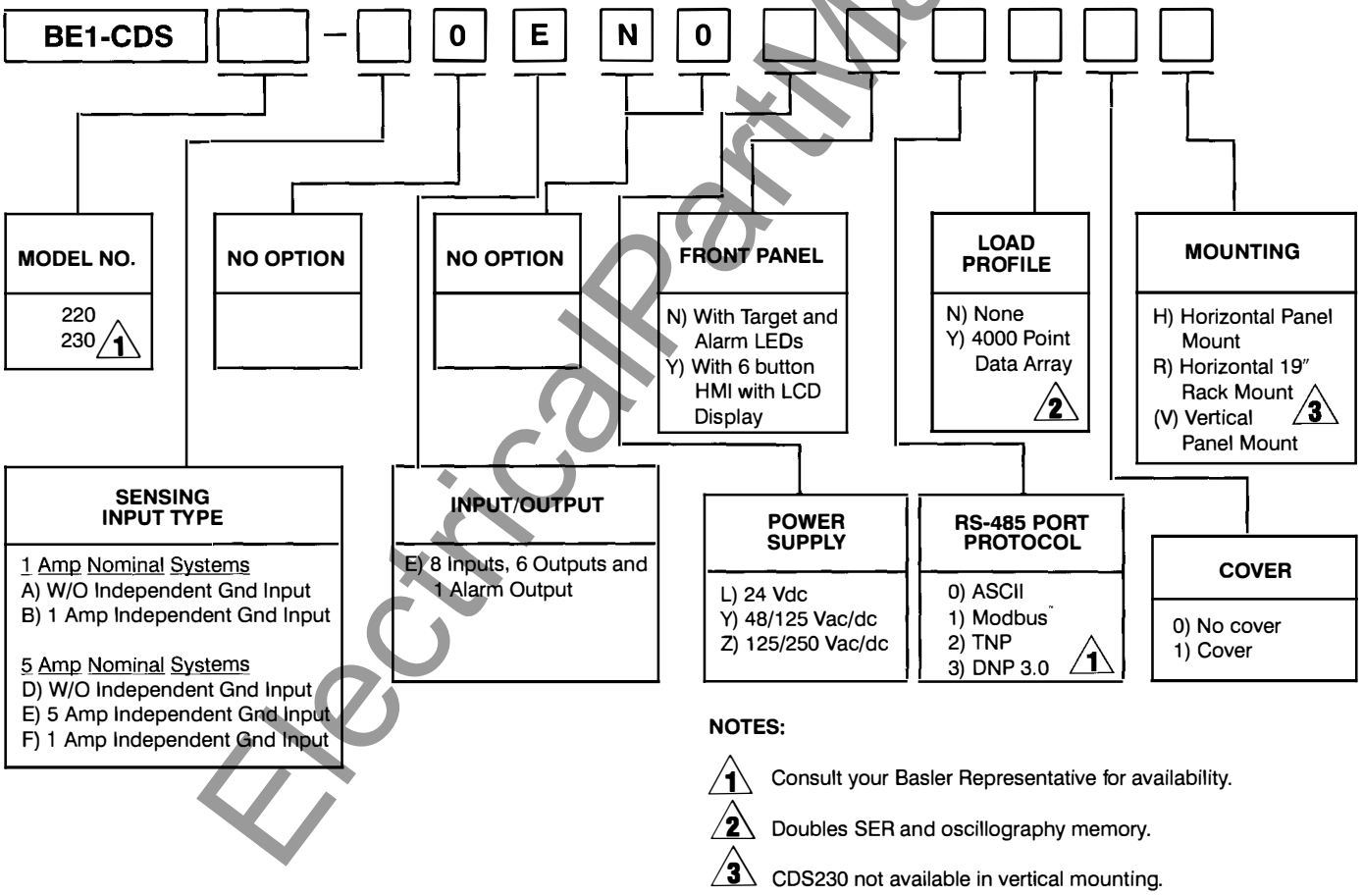
Accumulated Duty Alarm:	0-100%
Fault Counter Alarm:	0-99999

ORDERING

SAMPLE STYLE NUMBER

The style number identification chart defines the electrical characteristics and operation features included in BE1-CDS Relays. For example, if the style number were **CDS220 E0E-N0Y-Y0N0R**, the device would have the following:

- **(E)** - 5 Amp Nominal System with 5 Amp Independent Ground Input
- **(0)** - No Option
- **(E)** - 8 inputs, 6 programmable outputs, and 1 alarm output
- **(N)** - No Option
- **(0)** - No Option
- **(Y)** - 48/125 Vac/dc Power Supply
- **(Y)** - Six button HMI with graphic LCD
- **(0)** - ASCII Communications
- **(N)** - No Load Profile Recording
- **(0)** - No Cover
- **(R)** - Horizontal with 19" Rack Mount Brackets



NOTES:

1. Consult your Basler Representative for availability.
2. Doubles SER and oscillography memory.
3. CDS230 not available in vertical mounting.

STANDARD ACCESSORY

9180400109 MX Test Case with 2 CT Terminal Blocks.

Basler Electric

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