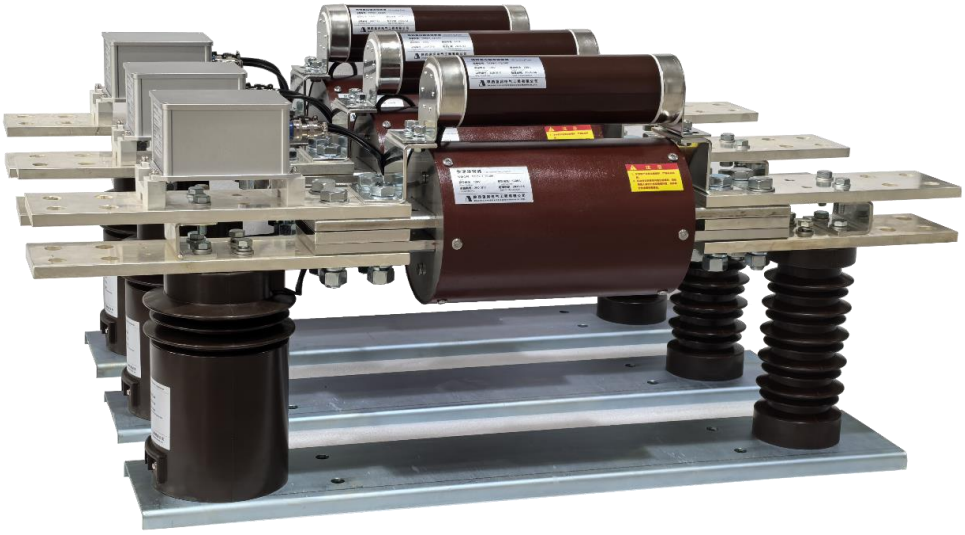
蓝河电气
LANHE ELECTRIC

DDX1 Series Fault Current Limiter



SHAANXI LANHE ELECTRICAL ENGINEERING CO., LTD.

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Application Characteristics

- The world's fastest circuit-breaking large-capacity switchgear
- There are nearly a thousand sets of production have been used in power distribution systems at home and abroad, and the function and reliability of the products have been tested
- Reduce the cost of substations
- Protect flimsy power equipment
- Solve the problem of short-circuit current exceeding after a new power supply is connected.
- Optimize the operation mode of the system
- In many cases, provide the only reasonable technical solution
- The actual current will be much lower than the peak of prospective current
- Very early current limiting at the first half wave
- A ideal solution to energy-saving and loss-reducing for the current-limiting reactor

1. Working Principle and Characteristics

1.1 The Basic Components of DDX1

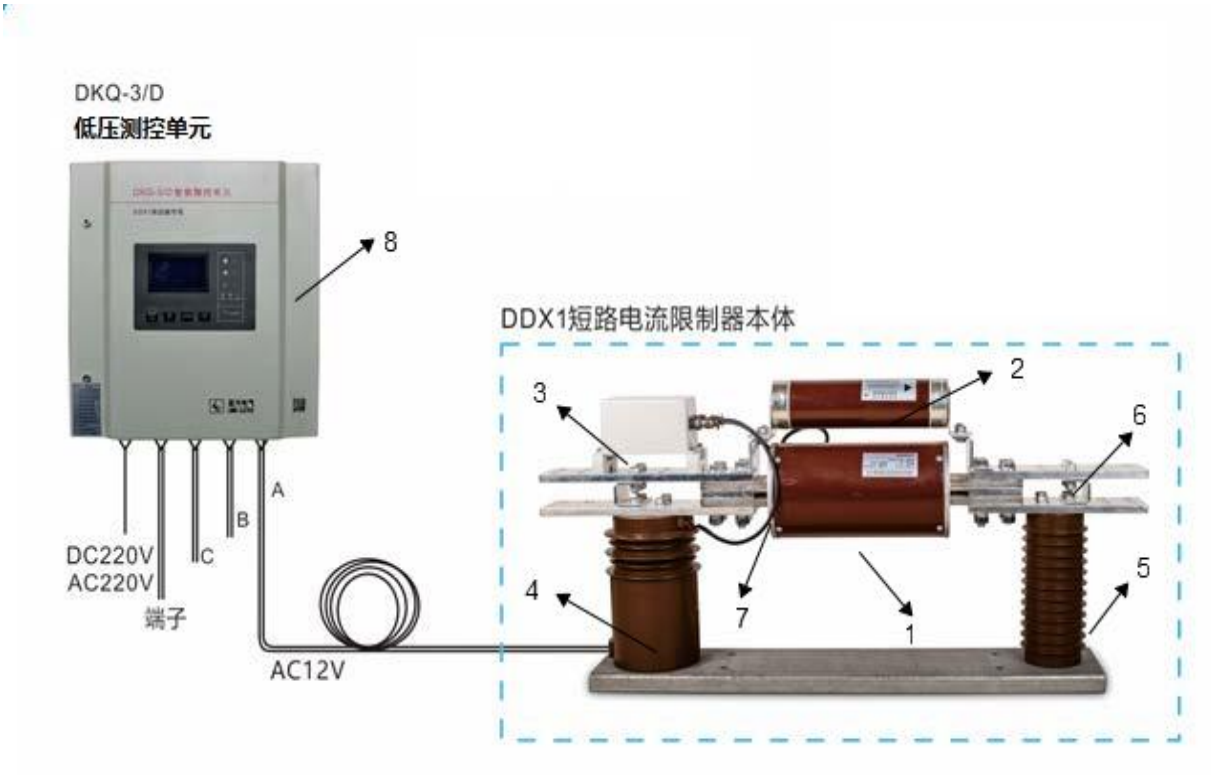


Fig1 The Basic Components of DDX1

1 Rapid Isolator Based on Explosive Cutting Technology

2 Special high-voltage current limiting fuse

3 Electronic controller

4 High-voltage isolating transformer

5 Insulator

6 Main busbar

7 Current sensor（inserted）

8 Analog measurement and control unit

The Basic Components of DDX1 are displayed in Fig1. Rapid isolator 1、fuse 2 and electronical controller 3 are the key parts of DDX1. The rapid isolator 1 and fuse 2 are connected in parallel to form the main conductive circuit of DDX1. The electronic contrller 3 controls the explosive cutting mechanism of the rapid isolator 1, while the analog measurement and control unit supplies power to DDX1 and indicates its operating status.

1.2 Explanation of the Principles

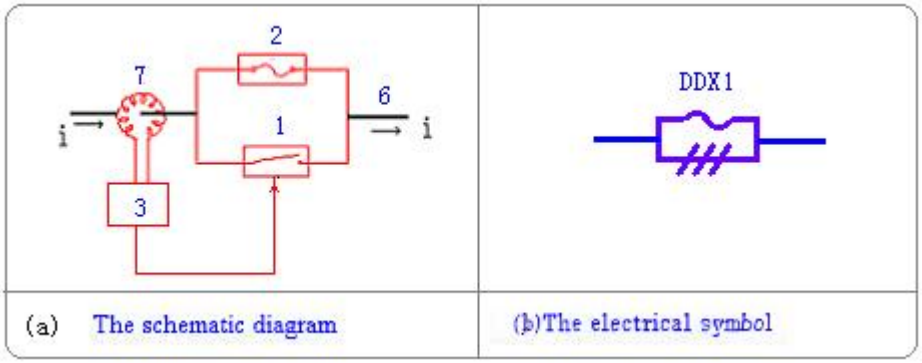


Fig2 The schematic diagram and the electrical symbol

In fig1 and , the analog measurement and control unit 8 supplies power to the electronic controller 3 through the isolating transformer 4, and indicate the operating conditions of DDX1 through visual indicators, relay contacts, counters, and other means. The rapid isolator 1 and the fuse 2 are electrically connected in parallel. Since the resistance of the rapid isolator 1 is in the micro-ohm range, whereas that of the fuse 2 is in the milliohm range, almost all the busbar current flows through the rapid isolator 1 under normal operating conditions. When a short-circuit fault occurs in the system, the current sensor 7 installed inside the rapid isolator1 transmits a signal representing the short-circuit current in busbar 6 to the electronic controller 3 via a signal cable. The controller 3 then analyzes and processes the signal. If the detected short-circuit current exceeds the preset threshold, the controller 3 outputs an ignition pulse to activate the actuator-- the explosive cutting mechanism-- inside the rapid

isoator 1, rapidly opening its conductive path within several hundred microseconds. As the conductive path of the rapid isolator 1 opens, the fault current commutates to the fuse 2, which then interrupts the short-circuit current and clears the fault.

The operating sequence of DDX1 during short-circuit current interruption is shown in Fig 3.

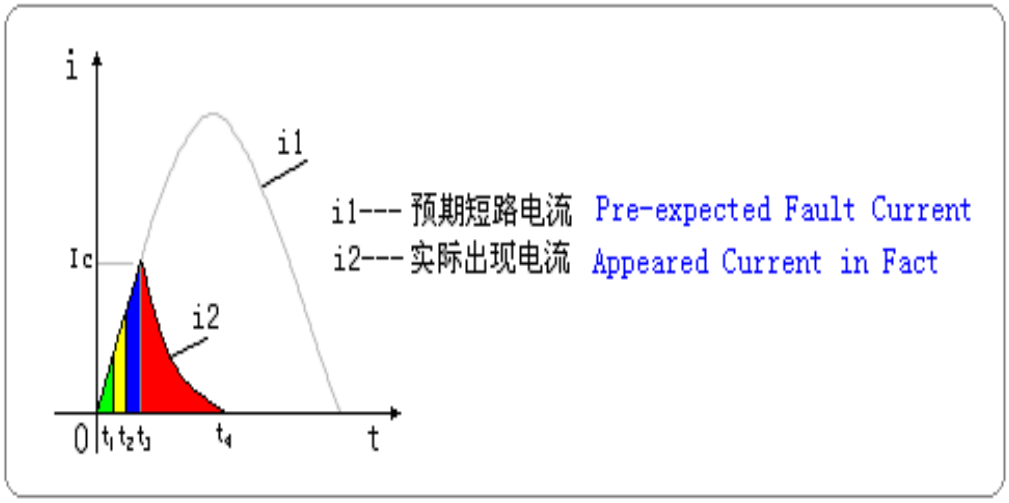


Fig3 The schematic diagram of DDX1's operating sequence

t=0 The short-circuit current occurs;

$t=t_1$ The electronic controller detects the fault and generates an ignition signal. The time required for this process depends on the magnitude of the prospective short-circuit current, the controller's preset operating threshold, and the phase angle at which the short circuit occurs. It is generally longer than 600 μs.

$t=t_2$ The contacts of the isolator separate, transferring the current to the current-limiting fuse. The time interval (t_2-t_1) is approximately 200 μs.

$t=t_3$ The fuse begins to arc. The interval(t_3-t_2) represents the fuse pre-arcing time, which is typically about 1 ms. I_c in the figure denotes the peak limited current.

$t=t_4$ The arc inside the fuse is extinguished, completely interrupting the fault curre nt. The interval (t_4-t_3) represents the fuse arcing time, which is generally less than 5 ms. The total interruption time, (t_4-t_3), is less than 10 ms.

Fig. 4 illustrates the waveform of a typical short-circuit current in a power system and compares the interruption performance of DDX1 with that of a conventional circuit breaker. As shown , DDX1 completes current-limiting interruption within a few milliseconds after a short-circuit fault occurs.

In contrast, a conventional circuit breaker, owing to the inherent operating characteristics of its protective relay and operating mechanism, requires several cycles to interrupt the fault current, typically at its natural current zero.

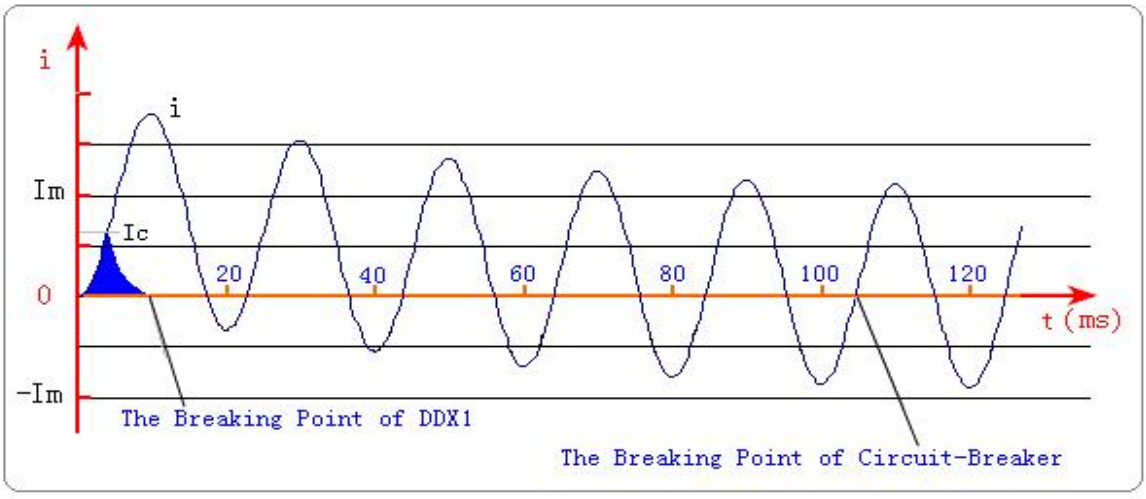


Fig4 Short-circuit current waveform and comparison of DDX1 with conventional circuit breaker.

Combining fig3 and fig4, it can be observed that DDX1 can interrupt the prospective short-circuit current at high speed and limit it before it reaches its peak.

The peak value I_c of the actual short-circuit current passing through the power equipment is limited to (15-50)% of the prospective short-circuit current peak within the first half-wave. The duration of the short-circuit current is less than 10 ms, which significantly reduces the total energy of the fault current $\int i^2dt$ (approximately 1/200 of that of a conventional circuit breaker), thereby more effectively protecting the main power equipment from damage.

Based on the characteristics of short-circuit currents in power systems, the electronic controller of the DDX1 current-limiting device employs two triggering criteria: the instantaneous current value i and the instantaneous rate of change of current di/dt. An actuation signal is generated only when both parameters simultaneously exceed their respective preset thresholds. This dual-criterion triggeing logic enhances the controller's immunity to interference while ensuring rapid operation of the DDX1.

The structural cutaway diagram of the fast isolator and the special current-limiting fuse after DDX1 actuation is shown in Figure 5.



Fig 5 The pictures after DDX1 activated

1.3 Explanation of the Characteristics

- High quality to break a fault current: 50kA~200kA
- High breaking speed (Full open time) : <10 ms
- Obvious current-limiting feature can limit the fault current to（15~50) % of its pre-expected value

- Rated current: 630A~6300A
- Rated voltage: 3.6kV~40.5kV
- Rated short-circuit breaking current:50 kA~200 kA
- Whole breaking time: < 10 ms
- The Rapid isolator and the fuse are fully sealed, less noise、high reliability and can be used indoors or outdoors
- The operating characteristics of the current-limiting device can be configured via the electronic controller using dual triggering criteria based on the instantaneous current and its rate of change
- The current sensor is integrated into the fast isolator, resulting in a simplified structural design
- The world's fastest short-circuit current-limiting switchgear
- Independent research and patent technology
- Military high-technology and explosive cutting technology under control
- More efficient to protect the power system and the main equipment
- A powerful weapon to solve fault current; A new product to reduce energy loss

2. Main Techinical Parameters

2.1 Table 1 Main Technical Data of DDX1

SN	Item		Unit	Technical Data
1	Rated current		A	630/2000/4000/6300
2	Rated voltage		kV	3.6/7.2/12/20/40.5
3	Rated frequency		Hz	50/60
4	Rated short-circuit breaking current		kA	50/63/100/150/200
5	The total breaking time		ms	<10
6	Rated Insulation Level(power frequency/lighting)	3.6	kV	/
		7.2	kV	23/60

		12	kV	42/75
		17.5	kV	38/95
		20	kV	50/125
		40.5	kV	95/185
7	Cut-off Current/ the peak value of prospective fault current		%	15~50
8	Main circuit DC resistance		μΩ	<40
9	Operating current setting range		kA	5~60
10	Rated short-circuit breaking current of the special HV current-limiting fuse		kA	63/100/150/200
11	Rated short-time withstand current of the main circuit		kA/s	40/3
12	Rated peak value withstand current of the main circuit		kA	100
13	Net distance between phases and phase to ground (indoor)		㎜	100/125/180/300
14	Specific creepage distance of insulator		㎜/ kV	＞25
15	Mechanical failing load of insulator		kN	＞12

2.2 Table 2 The Structure Dimensions (For reference only)

Rate Voltage (kV)	Rate Current (A)	A (mm)	B (mm)	CIndoor/Outdoor (mm)	D (mm)	E (mm)	F (mm)	G (mm)	Φ_1 (mm)	Φ_2 (mm)	Weight (kg)
3.6	800	1024	849	180	420	409	190	90	125	88	45
	1250~5000	1024	849		434	409			175		54/67
	8000	1125	905		445	460			205		75
7.2	630	1044	869	285/310	525	429	190	90	125	88	48
	1250~4500	1044	869		534	429			175		61/77
	7000	1145	970		545	525			205		87
12	630	1139	964	285/310	525	524	190	90	125	88	56
	1250~4000	1139	964		534	524			175		70/77
	6300	1240	1020		545	575			205		87
20	1250~3150	1316	1141	380/-	629	714	190	90	175	120	73/80
	5000	1417	1197		640	752	190	90	205		90
40.5	1500	1464	1289	390/430	668	849	220	110	175	120	82
	3150	1464	1289		686	849	220	110			92

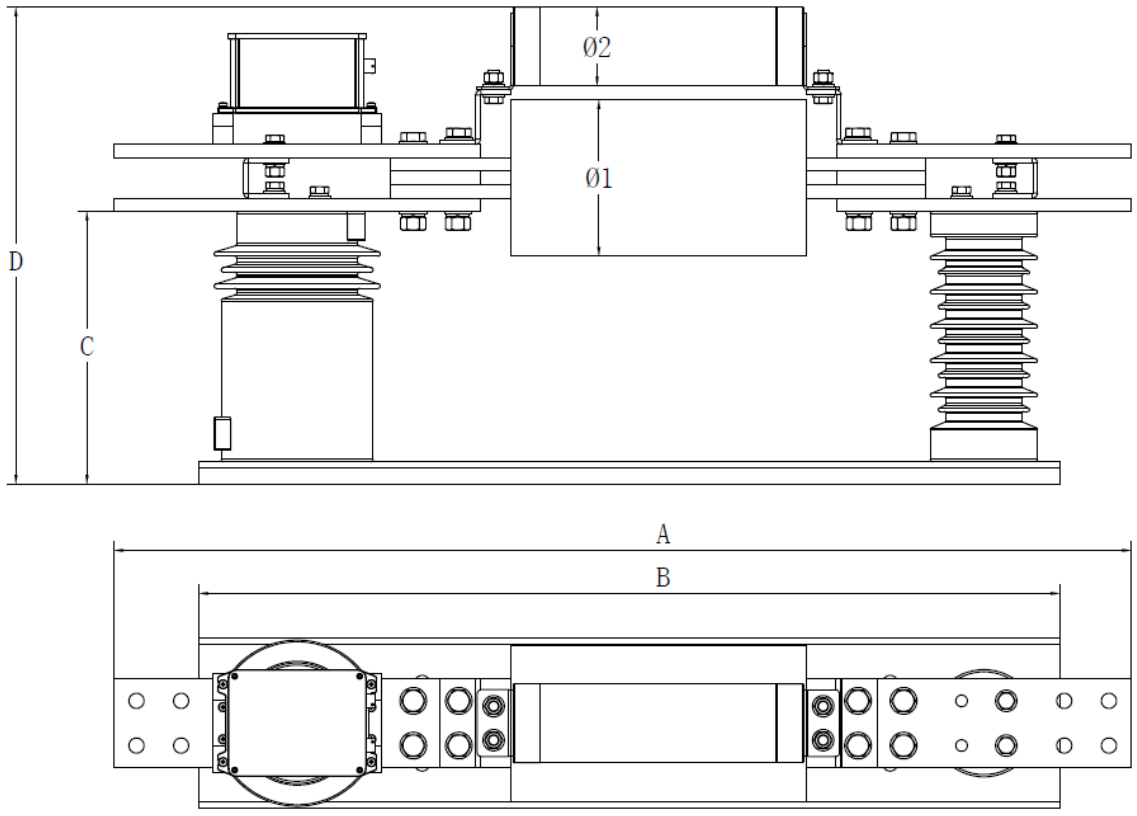
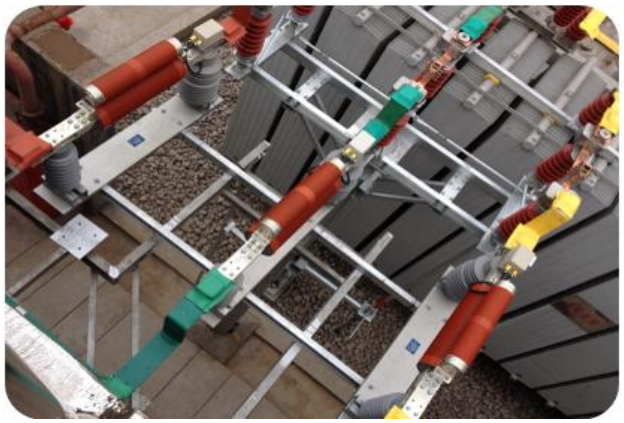


Fig6 The sketch map of structure dimensions

3. The Typical Structures and Project Cases

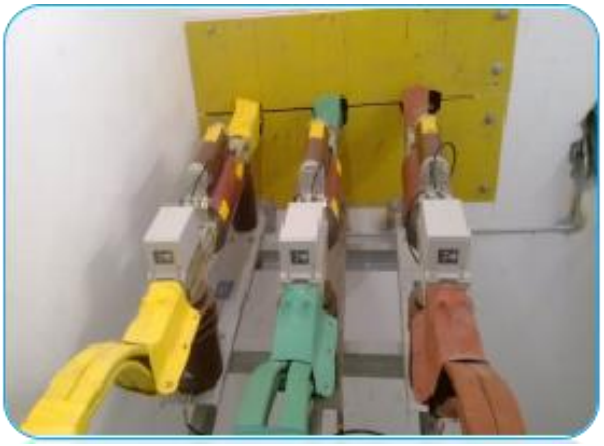
3.1 Cases of Single-phase Applications





(a) outdoor use



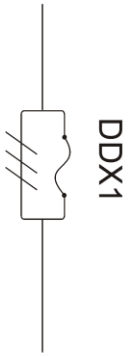
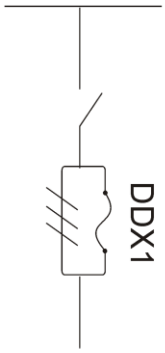
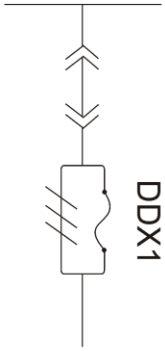
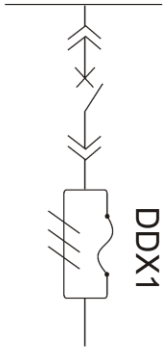
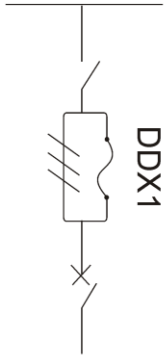


(b) indoor use

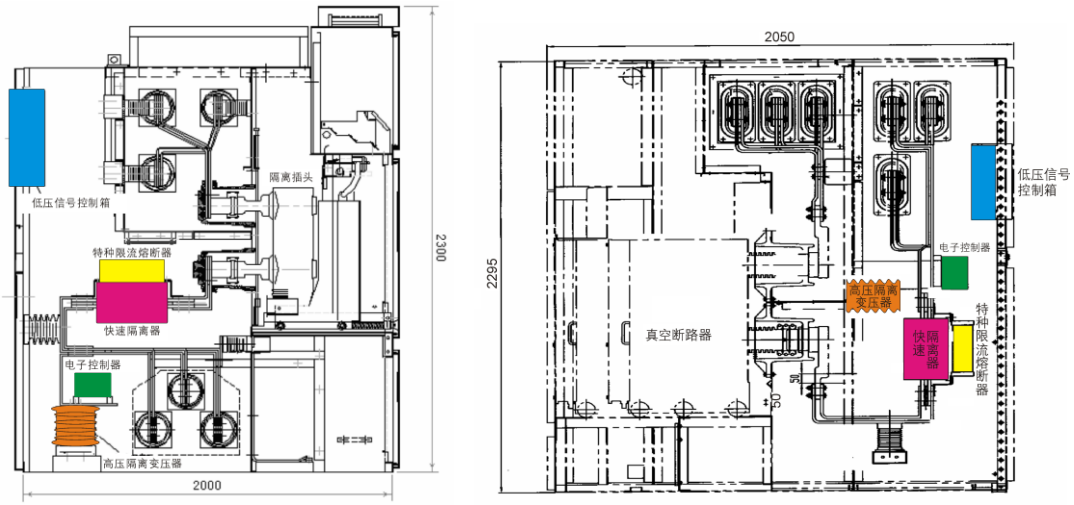
Fig6 DDX1 single-phase application (Reactor bypass)

3.2 Cases of Built-in Cabinet Applications

3.2.1 The Single Line Diagram of the Schemes

Example 1	Example 2	Example 3	Example 4	Example 5
				

3.2.2 The Cases of Typical Structure



Case 1



(b) Some Pictures

Fig7 The cases of typical cubic structure

4. The Typical Applications

4.1 DDX1 used for bypassing the current-limiting reactor

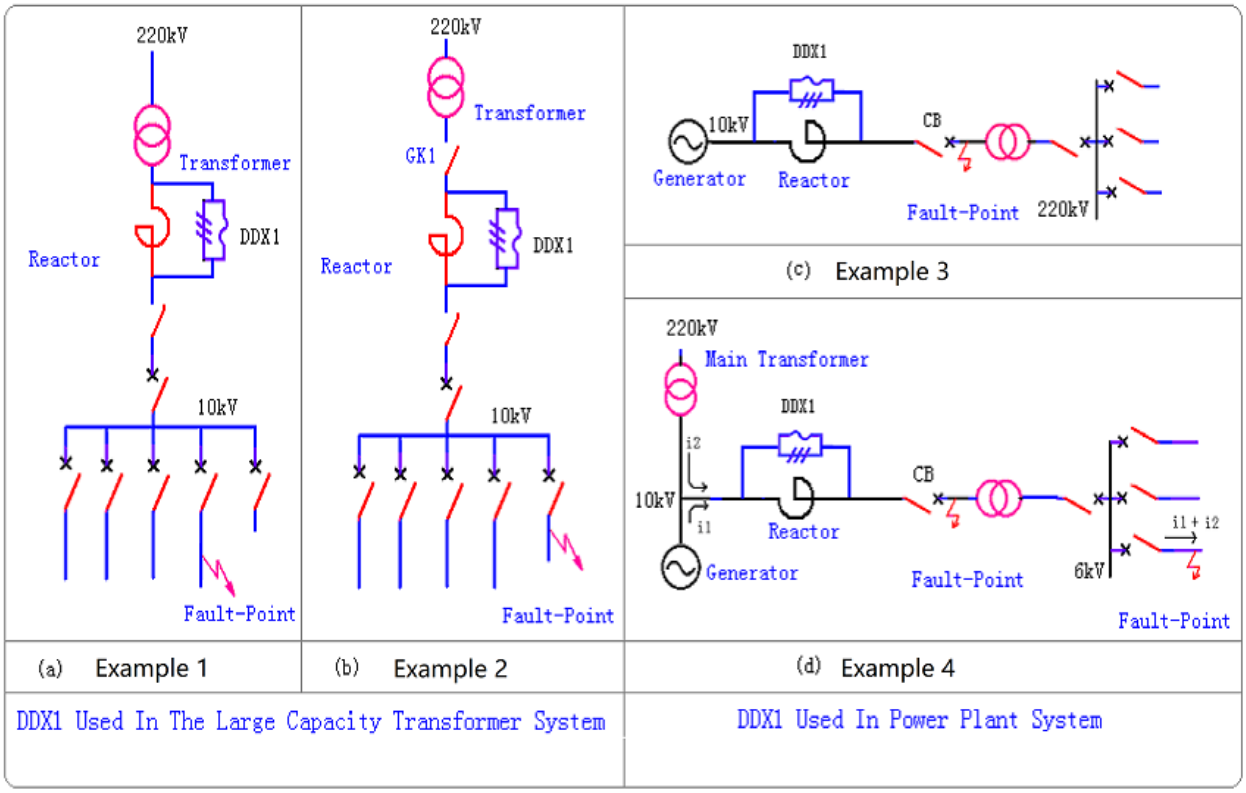


Fig8

The advantages of DDX1 in reactor bypass：

- Eliminates active power losses in the reactor
- Eliminates voltage drops caused by reactor impedance
- Avoids electromagnetic fields generated by the reactor

4.2 DDX1 used in the sectionalized busbars for parallel operation

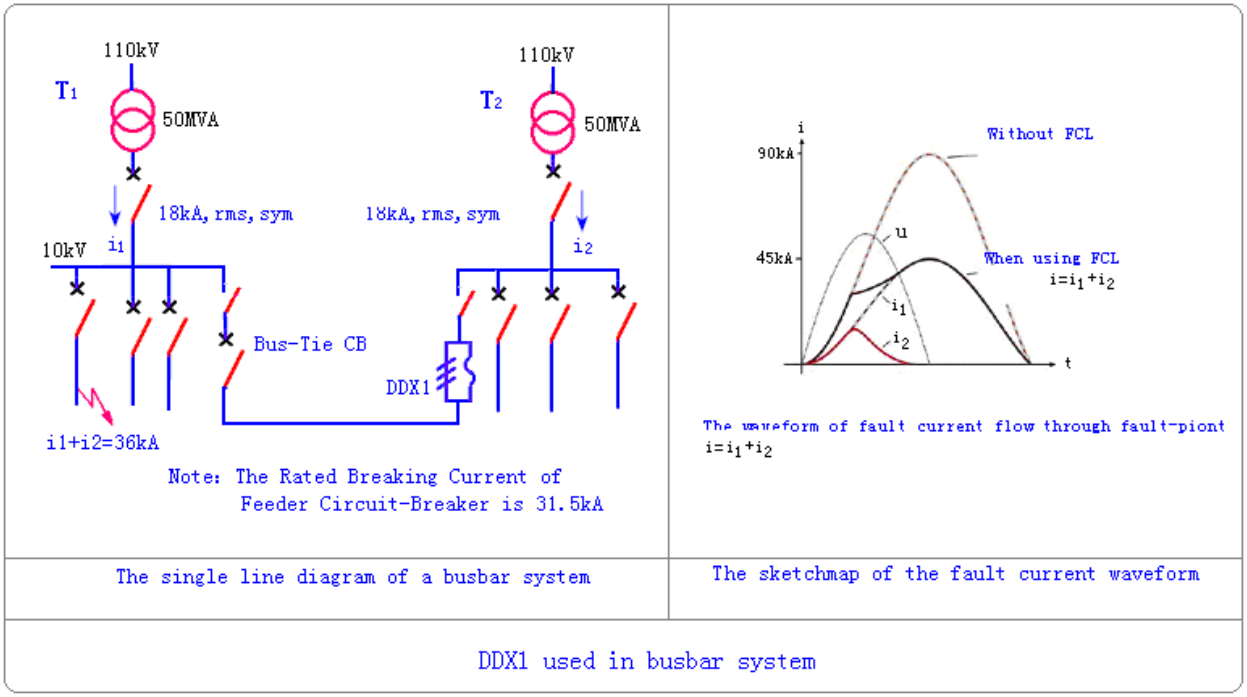


Fig9

The advantages of DDX1 used in busbars:

- Improves voltage quality
- Enhances system reliability
- Reduces network impedance
- Optimizes load distribution
- Enables capacity expansion without modifying the existing bubar configuration
- Enhances operational flexibility

4.3 DDX1 used in generator sets grids

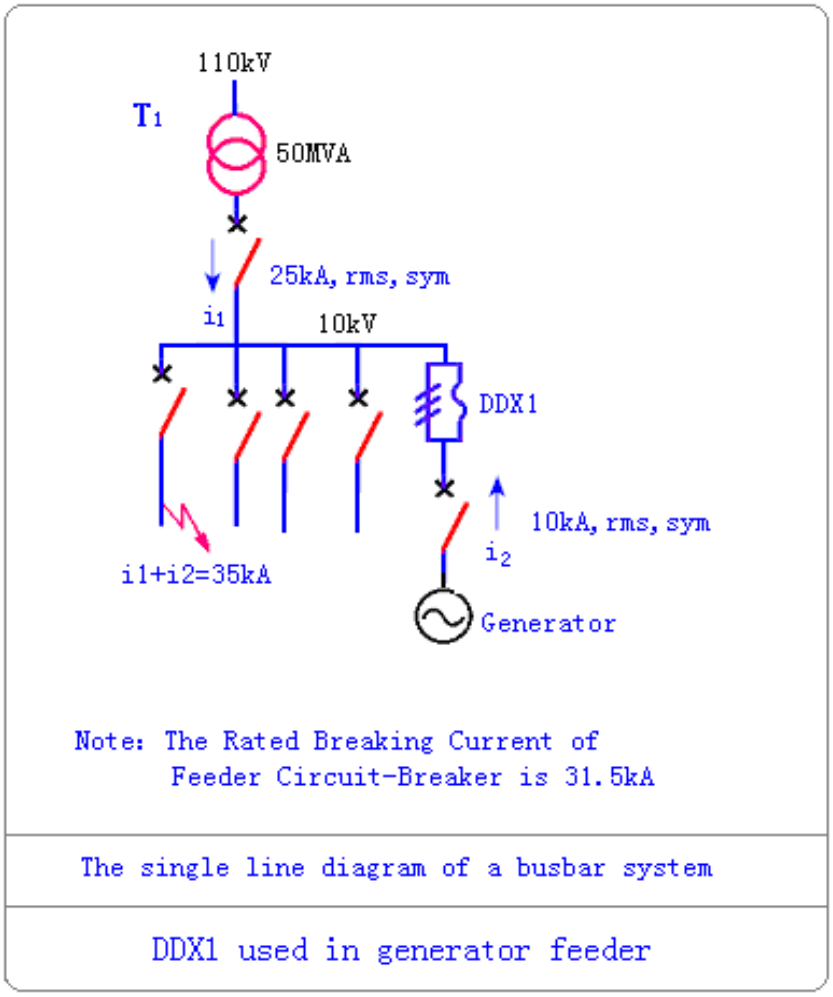


Fig10

The advantages of DDX1 used in generator grids:

- Generator integration without the need to consider the system short-circuit capacity system
- Eliminates the need for expensive generator circuit breakers
- Enables integration without modifying the existing busbar configuration

4.4 DDX1 used in power plant system or large capacity transformer

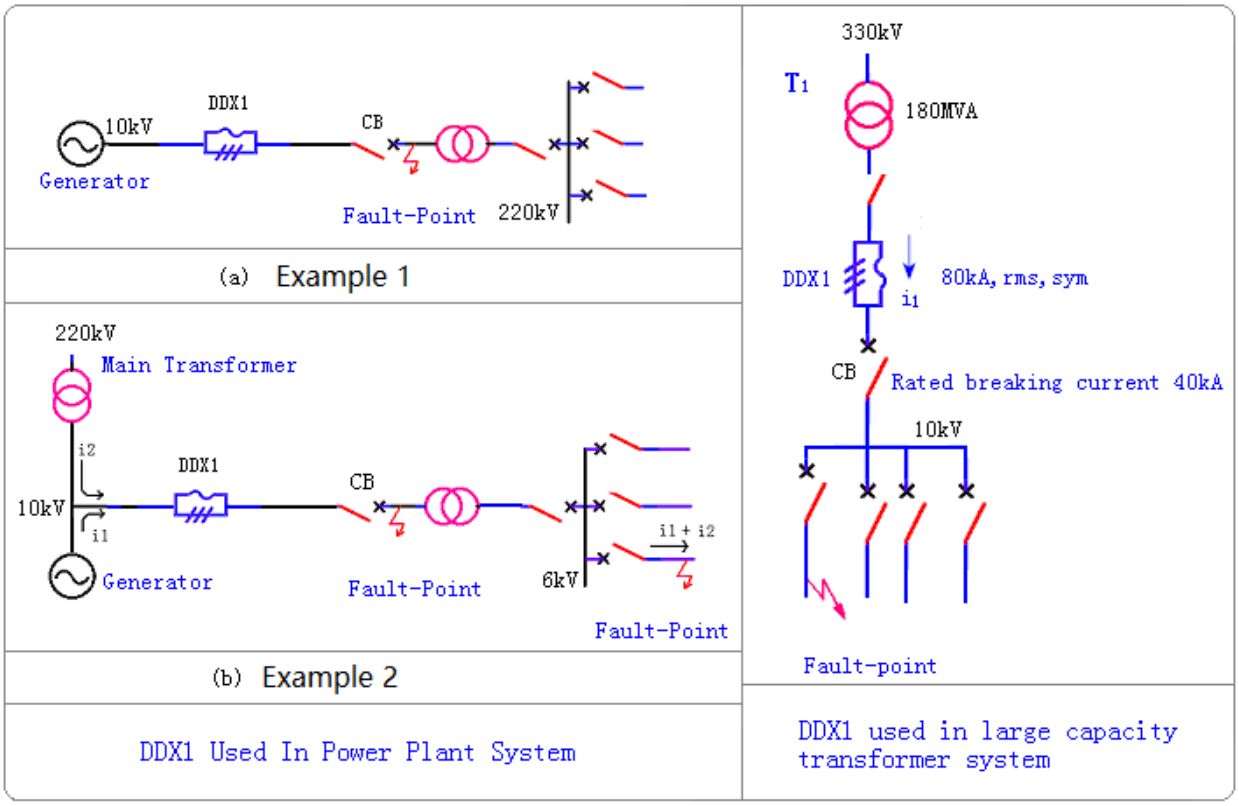


Fig11

The advantages of this application:

- Eliminates the need for expensive generator circuit breakers
- Eliminates the need for costly enclosed busbars
- Eliminates the need for current-limiting reactors
- Provides comprehensive short-circuit current protection in coordination with circuit breakers, enhancing the safety of the power system and its primary equipment

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