TOSHIBA

SURGE ARRESTER

RVLQ SERIES

1. General Introduction of Surge arrester

Toshiba surge arresters incorporate TNR elements (Toshiba Non-linear Resistor Zn0 Elements) with superior non-linear voltage-current characteristics, high quality and reliability.

Metal oxide type surge arresters offer such special features inherent in gap-less structure as quick response to surge voltage, high energy dissipation capability, safe operation, compactness / lightweight and freedom from pollution.

Toshiba surge arresters are applied for various systems including substation equipment, ACDC converters, rolling stock and power distribution units from 3.3kV to 800kV system. These surge arresters demonstrate excellent protection properties as shown in Figure 3.

Furthermore, based on the advantage of installation in Gas Insulated Switch-gear (GIS), these surge arresters are being used widely in almost all power transmission fields.

For over 80 years Toshiba has continuously endeavored to improve surge arrester technology and product quality, and has achieved positive results in manufacturing and employing the world's top-level techniques.

With leading technology and manufacturing equipment, Toshiba manufactures various surge arresters through careful application of our accumulated technology. Manufactured by modern facility under strict quality control, customers can depend on the high performance and reliability of Toshiba surge arresters.

In addition, we develop and manufacture various surge arresters, which can cope with such customer's requests as excellent performance (improvement of protection properties), compact design and lightweights, applying new and accumulated technology.

Microstructure of TNR

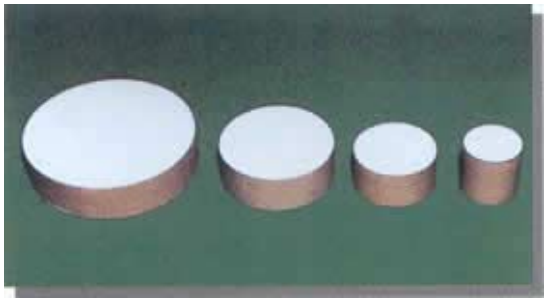

Figure 2. Elements Series

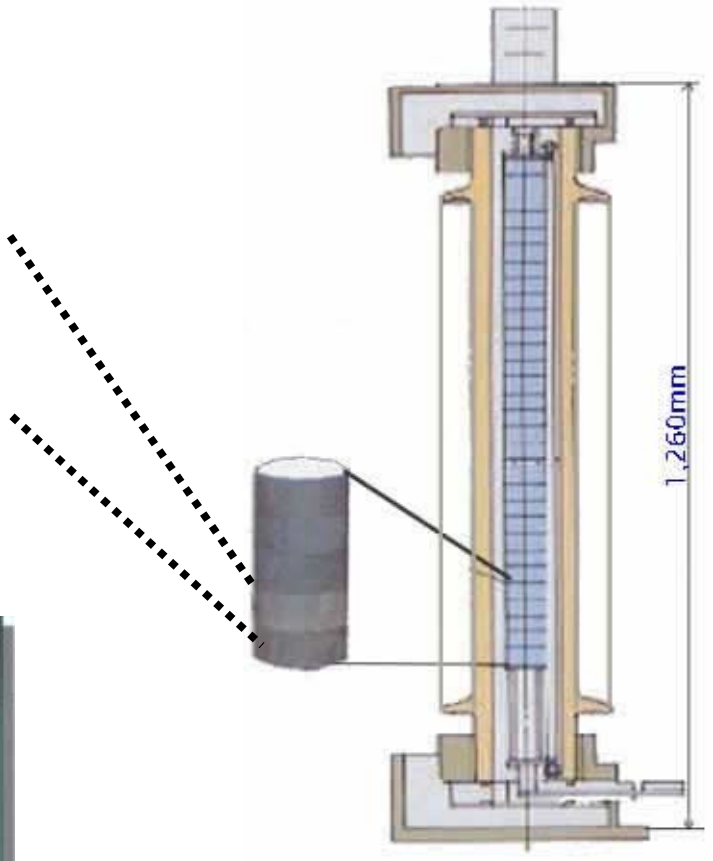

Figure 1. Construction of 72kV Surge Arrester

Figure 3. Variation of Surge Arresters

Toshiba surge arresters are applied to various systems to protect the power transmission apparatus from over-voltages

Figure 4. Various Applications

Toshiba 400kV surge arresters can be applied to extra heavy pollution area.

2. Feature

TNR Element

Superior Characteristics

Toshiba has sufficient manufacturing experience and endeavor continue development and improvement of TNR elements.

RVLQ series TNR elements are lined up applying Toshiba's these high and reliability techniques, high non-linearity of V-I characteristics, extremely high-energy absorption capability, superior life performance.

The V-I characteristics and energy absorption capability characteristics are extremely improved by applying the fruit of our studies over many years.

Manufacturing System

TNR elements are manufactured by using advanced facilities and modern testing devices and quality assurance systems, conforming the standard IS09001.

Quality Assurance

Toshiba operates a quality assurance program to achieve the best quality. Each TNR element is subjected to the check for the V-I characteristics.

Medium

TNR elements can be used in various mediums, such as SF6 gas and insulating oil.

Variation

Various size TNR elements can be prepared for customer's special requirements, considering the technical and economical requests such as high-energy durability for special application.

Using such a TNR element, special type surge arresters are

Surge Arrester

Superior Protective Performance

Applying the excellent operating performance TNR elements with high non-linearity of V-I characteristics and high energy absorption capability, Toshiba metal oxide surge arresters offer superior protective performance for the protecting of various systems and equipment against the various duties, such as lightning, switching and temporally over voltages.

Superior Characteristics against Environmental Contamination

Toshiba metal oxide type surge arresters successfully operate even in contaminated area, since they have merits such as excellent non-linearity and no-gap inherent in gap-less structure.

Compactness and Lightweight

Toshiba surge arresters feature compact, lightweight design. Compactness makes it possible to minimize installation space. Lightweight makes it easy to simplify basement structures such as pedestal and brackets.

Reliability

Toshiba surge arresters have simple construction and adopt the high reliable and robust porcelain housing. The surge arresters with firm and high quality construction are suitable for applying the various circumstance, such as the tropics, the frigid zone, in addition that the area where a series of earthquakes occurred.

Long term and sufficient manufacturing experience certificate the high reliability and quality of Toshiba surge arrester.

Compliance with Major standards

Toshiba surge arresters meet international standards IEC and ANSI and other relevant standards.

3. Operating Principle

The TNR element consists of the main component of ZnO and several kinds of additives, which are mixed, granulated, formed and sintered into a complete block with electrodes on the both surfaces.

Figure 5 shows a typical internal view of the TNR element under a scanning electron microscope. Composed of series and parallel connections of the ZnO grains and the boundary layers, the energy band model is shown as Figure 5. The boundary layer has a vary high impedance for a small current region, so the normal operating voltage is almost all applied to its boundary layer.

Figure 6 shows the V-I characteristics of the 550kV class surge arrester for example. The current flowing through the TNR element at the nominal line-to-ground voltage is on the order of micro-amperes. As a result, the protective performance of the TNR elements is stable in long term use, even though without series gaps.

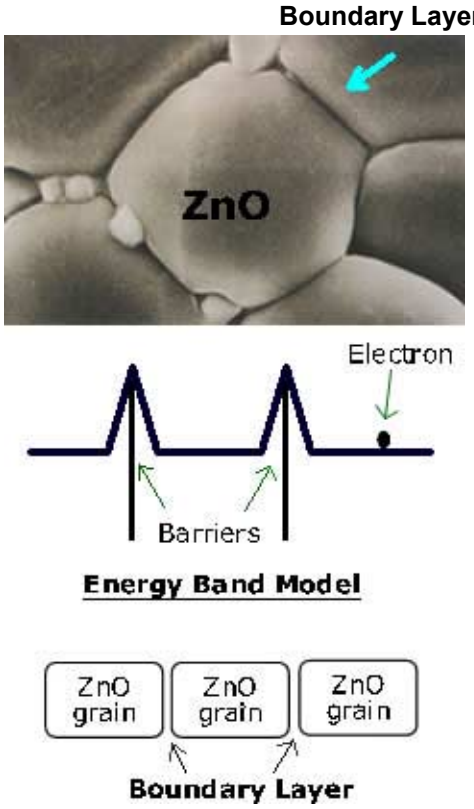

Figure 5. Conductivity Mechanism of TNR Element

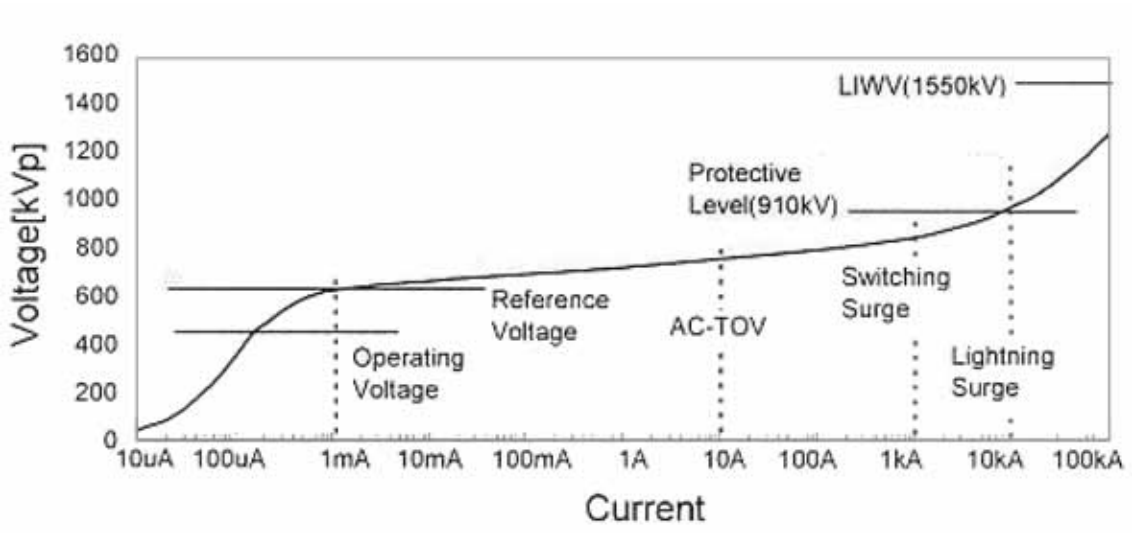

Figure 6. Representative V-I Characteristics for 500kV Arrester(RVLQA-420VY)

4. Performance

Toshiba's surge arresters, having no gap, comply with the latest revisions of IEC (IEC Pub.60099-4, 1991) and ANSI (IEEE Std C62.11-1993) or other relevant standards as station type surge arresters. Their principal characteristics of each type surge arrester are summarized in Table 1, and the detailed characteristics of each rating surge arrester are listed in Table 2 through Table 6.

RVLQD type surge arresters are applicable up to 245kV power systems.

RVLQC type surge arresters are applicable up to 420kV power systems.

RVLQB/E type surge arresters are applicable up to 550kV power systems.

RVLQA type surge arresters are applicable up to 800kV power systems, provide highest duty and lowest protective characteristics than the other four types.

Table 1. Standard Ratings

Type of surge arrester		RVLQD	RVLQC	RVLQB	RVLQE	RVLQA
System voltage [kV]		3-245	60-420	60-550	60-550	60-800
Rated voltage [kV]		3-198	54-360	54-492	54-492	54-624
Nominal discharge current In[kA]		10	10	20	20	20
Line discharge class	IEC	Class2	Class3	Class4	Class5	Class5
	ANSI	Station	Station	Station	Station	Station
High current impulse capability [kA]		100	100	100	100	100
Pressure relief class [kA]		20/50	50	65	65	65
Discharge voltage level ratio (Residual voltage at 1OkA / Rated voltage)		2.7	2.6	2.3	2.3	2.2
Energy capability [kJ/kV-Ur]		4.5	7	11	15	28

Note
1) Surge arrester with more heavy energy capability is available if required.
2) The energy capability values mean the dissipated total energy per two shots of switching surge that the surge arresters can withstand thermally with these values.

Rated Voltage

The maximum permissible rms value of power frequency voltage between the terminals of surge arrester at which it is designed to operate correctly under temporary over-voltage conditions as established in the operating duty test. The rated voltage is used as a reference parameter for the specification of operating characteristics.

Max. Continuous Operating Voltage (MCOV)

The maximum designated rms value of power frequency voltage that may be applied continuously between the terminals of the surge arrester. MCOV is one of the most important rating given to the surge arrester. This is because life performance and absence of thermal runaway is designed based on the magnitude of the MCOV in case of the surge arrester.

Protective Characteristics

Protective characteristics are summarized into residual voltage classified as follows:

1) Residual voltage for Impulse current of 8/20 sec, especially at nominal discharge current
2) Steep current impulse residual voltage
3) Switching impulse current residual voltage

The maximum guaranteed values of the surge arresters are listed in Table 2 trough Table 6.

Capability of Energy Dissipation

The capability of the surge arrester in energy dissipation against switching surge is well expressed by the magnitude of kJ/kV (arrester rated voltage). These values show the dissipated total energy per two shots of switching surge that the surge arresters can withstand thermally with these values. Where the energy capability is inadequate in our standard series, Toshiba can also supply a surge arrester of higher capability upon request.

Pressure-relief Class

The classification of standard pressure-relief is listed in Table-1. When placing an order, Toshiba will appropriate the customer's coincide requirements concerning the pressure-relief requirements.

Pollution Performance

RVLQ type surge arresters are applicable to heavy pollution area, when the creepage distance of the porcelain housing is designed to meet such a customer's requirements. Toshiba must be informed of the details.

Nominal Service Condition

Toshiba surge arresters are designed for normal indoor or outdoor operation under the following conditions:

1) Ambient air temperature within the range from 40 − C to +40 − C
2) Altitude not exceeding 1000m
3) Power voltage frequency from 48Hz to 62Hz

Type of Designation

The type designation gives the following information. The rated voltage, pollution level in accordance with IEC standard are found in the designation.

An example of the standard type designation is given below.

RVLQB-360HY

1) RVLQ is family name
2) B designates the type of the used TNR element, which is associated with IEC line discharge class (A: class 5, E: class 5, B: class 4, C: class 3, D: class 2 respectively).
3) 360 means rated voltage in kV.
4) H designates the pollution level in accordance with IEC standard. Following 4 different series are prepared for standard.

*Light (L) ---------- 16mm/kV

*Medium (M) ---------- 20mm/kV

*Heavy (H) ---------- 25mm/kV

*Very Heavy (V) -------- 31 mm//kV

Creepage distance over 31 mm/kV are available on request.

5. Outline Dimensions

Dimensions

Figure 7 and Table 7 show the representative dimension of the standard class surge arrester (Pollution Level: Very Heavy).

Standard Mechanical Strength

The maximum permissible bending strength of surge arrester can be calculated by dividing the listed maximum bending moment with the surge arrester height.

Table 2. Performance of t e RVLQD

Rated Voltage [kVrms]	Max. continuous operating voltage [kVcrest]	Max. residual voltage at indicated impulse current at 8/20us [kVcrest]				* Max. switching surge protective level [kVcrest]			** Steep current impulse residual voltage [kVcrest]	
		V5kA	V10kA	V20kA	V40kA	500A	1000A	2000A	10kA	20kA
3	2.6	7.30	8.05	9.23	11.2	6.17	6.44	6.76	8.85	10.2
4.5	3.9	11.0	12.1	13.9	167	926	9.65	10.1	133	153
6	5.1	14.7	16.1	18.5	22.3	12.31	12 9	13.5	17.7	20 4
7.5	64	19.1	20.8	239	289	16.0	16.7	17.5	229	264
9	7.7	22.8	24.9	28.5	34.4	19.1	19.9	20.9	27.3	31.4
10	8 5	24 8	27.1	31 1	37 5	20.8	21 6	22 7	29 8	34 2
10.5	9.0	26.8	29.2	33.6	40.5	22.4	23.4	24.6	32.2	37.0
12	10 2	30 1	32.9	37 8	45 5	25.2	26 3	27 7	36 2	41 6
15	12.8	37.5	40.9	47.0	56.7	31.4	32.8	34.4	45, 0	51.7
18	15 3	44 8	49.0	56 2	67 8	37.6	39 2	41.2	53 9	61 9
21	17.1	52.2	57.0	65.5	78.9	43.7	45.6	47.9	62.7	72.0
24	19.5	60.2	65.8	75 5	91.0	50 5	52 6	55 3	72 4	83 1
27	21.9	67.6	73.8	84.7	102	56.6	59.1	62.1	81.2	93.3
30	24 3	74.9	81.9	94 0	113	62 8	65.5	68 8	90 1	103
33	26.8	82.3	89.9	103	124	69.0	719	75.6	98.9	114
36	29.2	90.3	98.7	113	137	75 7	78.9	83.0	109	125
39	31.6	97.7	107	123	148	81.9	85.4	89:7	117	135
42	341	105	115	132	159	88.0	918	96.5	126	145
45	36 5	115	126	144	174	96.4	101	106	138	159
48	38.9	120	132	151	182	101	105	111	145	166
51	41.4	130	143	164	197	109	114	120	157	180
54	43 8	135	148	170	204	113	118	124	163	187
60	48.6	151	165	189	228	126	132	138	181	208
66	53 5	168	184	211	254	141	147	154	202	232
72	58.4	131'	197	227	273	151	158	166	217	249
78	63 2	198	216	248	299	166	173	182	238	273
84	68.1	214	230	264	319	177	184	194	253	291
90	72.9	228	249	286	345	191	199	210	274	315
96	77.8	241	263	302	364	202	211	221	290	332
108	87 5	271	296	340	410	227	237	249	326	374
120	97.2	301	329	378	455	252	263	277	362	415
132	107	331	362	415	501	278	290	304	398	457
144	117	361	395	453	546	303	316	332	434	498
156	126	391	428	491	592	328	342	360	470	540
168	136	422	461	529	637	353	368	387	507	582
172	139	432	472	541	652	362	377	396	519	595
180	146	452	494	566	683	379	395	415	543	623
192	156	482	526	604	728	404	421	442	579	665
196	159	492	537	617	743	412	430	452	591	678
198	160	499	545	626	754	418	436	458	600	689

The wave shapes of switching surge and steep current impulse are as follows.

* Switching surge current impulse :virtual front time greater than 30us but less than 100us
** Steep current impulse :virtual front time of 1 us with limits

Table 3. Performance oft a RVLQC

Rated Voltage [kVrms]	Max. continuous operating voltage [kVrms]	Max. residual voltage at indicated impulse current at 8/20us [kVcrest]				* Max. switching surge protective level [kVcrest]			** Steep current impulse residual voltage [kVcrest]	
		V5kA	V10kA	V20kA	V40kA	500A	1000A	2000A	10kA	20kA
54	43.8	128	138	154	179	1018	112	118	152	170
60	48 6	144	156	174	202	122	127	133	171	191
66	53.5	154	167	187	217	131:	136	142	184	205
72	58 4	172	187	209	243	146	152	159	205	230
78	63.2	186	201	225	261	157	163	171	221	247
84	68.1	199	215	241	280	168	175	184	237	265
90	72.9	212	230	257	298	180	187	196	253	282
96	77.8	225	244	273	317	191	198	208	268	300
108	87.5	260	282	315	366	220	229	240	310	346
120	97 2	286	310	347	403	243	252	264	341	381
132	107	313	339	379	440	265	275	289	373	417
144	117	339	367	411	477	287	299	313	404	452
156	127	371	402	449	522	314	326	342	442	494
168	137	397	430	481	559	336	350	367	473	529
172	140	405	439	491	570	343	357	374	483	540
180	146	424	459	513	596	359	373	391	505	564
192	156	450	488	545	634	381	396	416	536	600
196	159	463	502	561	652	392	408	428	552	617
198	161	472	511	571	664	399	415	435	562	628
200	162	477	516	577	671	404	420	440	568	635
204	166	485	525	587	682	411	427	448	578	646
216	175	511	554	619	719	433	450	472	609	681
228	185	543	588	657	764	460	478	501	647	723
240	195	569	617	689	801	482	501	526	678	758
252	205	596	645	721	838	504	524	550	710	794
258	209	609	660	738	857	516	536	562	726	811
264	214	622	674	754	876	527	548	574	741	829
276	224	657	711	795	924	556	578	606	783	875
288	234	683	740	827	962	578	601	631	814	910
294	239	696	754	843	980	590	613	643	830	928
300	243	715	774	866	1006	605	629	660	852	952
306	248	728	789	882	1025	616	641	672	867	970
312	253	741	803	898	1043	628	652	684	883	987
324	263	768	832	930	1080	650	676	709	915	1023
342	278	807	875	978	1136	684	711	745	962	1076
360	292	847	918	1026	1192	717	746	782	1009	1128

The wave shapes of switching surge and steep current impulse are as follows

* Switching surge current impulse :virtual front time greater than 30us but less than 100us
**Steep current impulse :virtual front time of 1us with limits

Table 4. Performance oft type RVLQB

Rated voltage [kVrms]	Max. continuous operating voltage [kVrms]	Max. residual voltage at indicated impulse current at 8/20us [kVcrest]				*Max. switching surge protective level [kVcrest]			** Steep current impulse residual voltage [kVcrest]	
		5kA	1OkA	V20kA	V40kA	500A	1000A	2000A	10kA	20kA
54	43.8	116	125	138	154	99	103	108	137	152
60	48.6	128	138	153	170	109	113	119	152	168
66	53.5	146	151	167	186	119	124	130	166	183
72	58.4	157	169	187	208	134	139	145	186	205
78	63.2	169	182	201	224	144	150	156	200	221
84	68.1	181	195	215	240	154	160	168	214	237
90	72.9	193	208	230	256	164	171	179	228	253
96	77.8	205	221	244	272	175	181	190	243	268
108	87.5	232	249	276	307	197	205	215	274	303
120	97 2	256	275	305	339	218	226	237	303	335
132	107	284	306	339	377	242	252	263	337	373
144	117	308	332	367	409	263	273	286	365	404
156	127	332	358	396	441	283	294	308	394	436
168	137	361	389	430	479	308	320	335	428	473
172	140	368	397	439	489	314	326	341	436	483
180	146	385	415	459	511	328	341	357	456	505
192	156	409	441	488	543	349	362	379	485	536
196	159	421	454	502	559	359	373	390	499	552
198	161	421	454	502	559	359	373	390	499	552
200	162	457	492	545	607	390	405	424	542	599
204	166	441	474	525	585	375	390	408	522	577
216	175	465	500	554	617	396	411	430	550	609
228	185	489	526	582	648	416	433	453	579	641
240	195	513	552	611	680	437	454	475	607	672
252	205	537	578	640	712	457	475	497	636	704
258	209	553	596	660	734	471	490	513	656	725
264	214	566	609	674	750	482	501	524	670	741
276	224	590	635	703	782	502	522	546	698	773
288	234	614	661	731	814	523	543	568	727	804
294	239	626	674	746	830	533	554	579	741	820
300	243	645	694	769	856	549	571	597	764	845
306	248	657	707	783	872	560	582	609	778	861
312	253	662	712	788	878	564	586	613	784	867
324	263	693	746	826	920	590	614	642	821	908
342	278	734	790	874	974	625	650	680	869	962
360	292	770	829	917	1022	656	682	713	912	1009
378	307	806	868	960	1069	887,	714	747	955	1056
390	316	830	894	989	1101	707	735	769	983	1088
396	321	842	907	1003	1117	717	746	780	997	1104
420	341	890	958	1061	1181	758	788	824	1054	1167
444	360	950	1023	1132	1261	809	841	880	1125	1246
468	380	998	1075	1190	1325	850	884	925	1182	1309
492	399	1046	1127	1247	1389	891	926	969	1239	1372

The wave shapes of switching surge and steep current impulse are as follows.

* Switching surge current impulse :virtual front time greater than 30us but less than 100us
** Steep current impulse :virtual front time of 1 us with limits

Table 5. Performance oft a RVLQE

Rated Voltage [kVrms]	Max. continuous operating voltage [kVrms]	Max. residual voltage at indicated impulse current at 8/20us [kVcrest]				* Max. switching surge protective level [kVcrest]			**Steep current impulse residual voltage [kVcrest]	
		V5kA	V10kA	V20kA	V40kA	500A	1000A	2000A	10kA	20kA
54	43.8	115	123	136	152	99	103	107	135	149
60	48.6	127	136	150	167	110	113	118	150	165
66	53.5	143	154	170	189	124	128	134	169	186
72	58 4	151	161	178	199	130	135	140	178	196
78	63.2	163	174	192	215	140	145	152	192	211
84	68.1	175	187	206	230	151	156	163	206	227
90	72.9	187	200	220	246	161	167	174	220	242
96	77 8	198	213	235	262	171	177	185	234	258
108	87.5	222	238	263	293	192	199	207	262	289
120	97 2	246	264	291	325	212	220	229	290	320
132	107	275	294	325	362	237	245	256	323	357
144	117	298	320	353	394	257	267	278	352	388
156	127	322	345	381	425	278	288	306	380	419
168	137	346	371	409	457	298	309	322	408	450
172	140	353	379	418	466	305	316	329	416	459
180	146	370	396	437	488	319	330	344	436	481
192	156	394	422	465	520	340	352	367	464	512
196	159	401	430	474	529	346	358	373	472	521
198	161	406	435	480	535	350	362	378	478	527
200	162	413	442	488	545	356	369	385	487	537
204	166	418	447	494	551	360	373	389	492	543
216	175	444	476	525	586	383	397	414	523	577
228	185	468	501	553	617	404	418	436	551	608
240	195	492	527	581	649	424	439	458	579	639
252	205	520	557	615	686	449	465	484	613	676
258	209	532	570	629	702	459	475	496	627	692
264	214	544	583	643	718	469	486	507	641	707
276	224	568	608	671	749	490	507	529	669	738
288	234	596	639	706	787	514	533	555	703	775
294	239	608	652	719	803	525	543	566	717	791
300	243	620	664	733	818	536	554	578	731	806
306	248	632	677	747	834	545	565	589	745	822
312	253	644	690	761	850	555	575	600	759	837
324	263	668	715	790	881	576	596	622	787	868
342	278	703	754	832	929	607	628	655	829	915
360	292	739	792	874	976	638	660	688	871	961
378	307	775	830	916	1023	668	692	722	913	1008
390	316	799	856	945	1054	689	714	744	941	1039
396	321	811	869	959	1070	699	724	755	955	1054
420	341	870	932	1029	1149	751	777	811	1026	1132
444	360	918	983	1085	1212	792	820	855	1082	1194
468	380	966	1035	1142	1275	833	862	899	1138	1256
492	399	1013	1086	1198	1337	874	905	944	1194	1318

The wave shapes of switching surge and steep current impulse are as follows.

* Switching surge current impulse :virtual front time greater than 30us but less than 100us
**Steep current impulse :virtual front time of 1us with limits

Table 6. Performance oft a RVLQA

Rated Voltage [kVrms]	Max. continuous operating voltage [kVrms]	Max. residual voltage at indicated impulse current at 8/20us [kVcrest]				* Max. switching surge protective level [kVcrest]			* *Steep current impulse residual voltage [kVcrest]	
		V5kA	V10kA	V20kA	V40kA	500A	1000A	2000A	10kA	20kA
54	43.8	111	118	126	141	101	104	108	130	138
60	48.6	123	130	139	156	111	115	120	143	153
66	53.5	140	149	159	178	127	131	137	164	175
72	58.4	152	161	172	192	137	142	148	177	189
78	63.2	163	173	185	207	148	153	159	191	204
84	68.1	175	186	198	222	159	164	171	204	218
90	72.9	186	198	212	237	169	175	182	218	233
96	77.8	198	210	225	252	180	186	194	231	247
108	87.5	221	235	251	281	201	208	216	259	276
120	97.2	250	266	284	318	227	235	245	293	313
132	107	274	291	311	348	248	257	267	320	342
144	117	297	315	337	377	269	278	290	347	371
156	126	320	340	363	407	290	300	313	374	400
168	136	343	365	390	436	311	322	335	401	429
172	139	355	377	403	451	322	333	347	415	443
180	146	367	390	416	466	332	344	358	428	458
192	156	396	420	449	503	359	371	387	462	494
196	159	402	427	456	510	364	376	392	469	501
198	160	407	433	462	517	369	382	398	476	509
200	162	413	439	469	525	375	387	404	483	516
204	165	419	445	476	532	380	393	409	490	523
216	175	442	470	502	562	401	415	432	517	552
228	185	465	495	528	591	422	436	455	544	581
240	194	489	519	555	621	443	458	477	571	610
252	204	518	550	588	658	469	485	506	605	646
258	209	529	562	601	672	480	496	517	619	661
264	214	541	575	614	687	490	507	529	632	676
276	224	564	600	641	717	511	529	551	659	705
288	233	588	624	667	746	533	551	574	687	734
294	238	599	637	680	761	543	562	585	700	748
300	243	611	649	693	776	554	573	597	714	763
306	248	622	661	707	790	564	583	608	727	777
312	253	640	680	726	813	580	600	625	748	799
324	263	663	704	753	842	601	622	648	775	828
342	277	698	742	792	886	633	654	682	816	871
360	292	733	779	832	931	664	687	716	856	915
378	306	774	822	878	982	701	725	756	904	966
390	316	797	847	904	1012	722	747	778	931	995
396	321	808	859	918	1027	733	758	790	945	1009
420	340	855	908	970	1086	775	801	835	999	1067
444	360	907	964	1030	1152	822	850	886	1060	1133
468	379	954	1013	1083	1211	864	894	932	1115	1191
492	399	1006	1069	1142	1278	912	943	983	1176	1256
540	437	1099	1168	1248	1396	996	1030	1074	1284	1372
564	457	1151	1223	1307	1462	1044	1079	1125	1345	1438
576	467	1175	1248	1333	1492	1065	1101	1147	1373	1467
588	476	1198	1273	1360	1521	1086	1123	1170	1400	1496
600	486	1221	1297	1386	1551	1107	1145	1193	1427	1525
612	496	1244	1322	1413	1580	1128	1166	1216	1454	1554
624	506	1273	1353	1446	1617	1154	1194	1244	1488	1590

The wave shapes of switching surge and steep current impulse are as follows.

* Switching surge current impulse :virtual front time greater than 30us but less than 100us
**Steep current impulse :virtual front time of 1us with limits

Table 7. Dimensions of type RVLQD, RVLQC, RVLQB, RVLQE, RVLQA

Type	Rated voltage [kVrms]	Dimensions							Creepage Distance [mm]	Approx. mass [kg]	Maximum Bending Moment [Nm]
		Fig.	Approx. Height H [mm]	Grading Ring dia.D [mm]	Insulator dia.d1 [mm]	Base A [mm]	Base B [mm]	Base C [mm]			
RVLQD	3-12	(a)	300	-	140	-	-	-	220	15	5070
	15-39	(b)	750	-	260	240	280	15	1640	60	6500
	42-84	(b)	1100	-					2990	70	
	90-120	(b)	1500	-					4340	80	
	132-174	(c)	2100	600					5980	160	
	180-198	(c)	2850	600					8680	180	
RVLQC	42-84	(b)	1100	-	260	240	280	15	2990	60	6500
	90-120	(b)	1500	-					4340	70	
	132-174	(c)	2100	600					5980	80	
	180-216	(c)	2850	600					8680	160	
	228-360	(d)	4360	1400	300	270	320	19	13020	180	10000
RVLQB	54-120	(b)	1500	-	300	270	320	19	4340	125	15000
	132-216	(c)	2900	600					8680	280	
	228-390	(d)	4400	1400					13020	420	
	396-492	(e)	5900	2000	325	330	380	24	17360	560	21000
RVLQE	54-120	(b)	1550	-	325	330	380	24	4340	165	24000
	132-216	(c)	2950	600					8680	360	
	228-390	(d)	4500	1400					13020	500	
	396-492	(e)	5950	2000					17360	650	
RVLQA	54-120	(b)	1550	-	345	330	380	24	4340	215	31000
	132-216	(c)	2950	600					8680	450	
	228-390	(d)	4500	1400					13020	700	
	396-492	(e)	5900	200					17360	900	
	540-624	(f)	7300	2500					26040	1200	

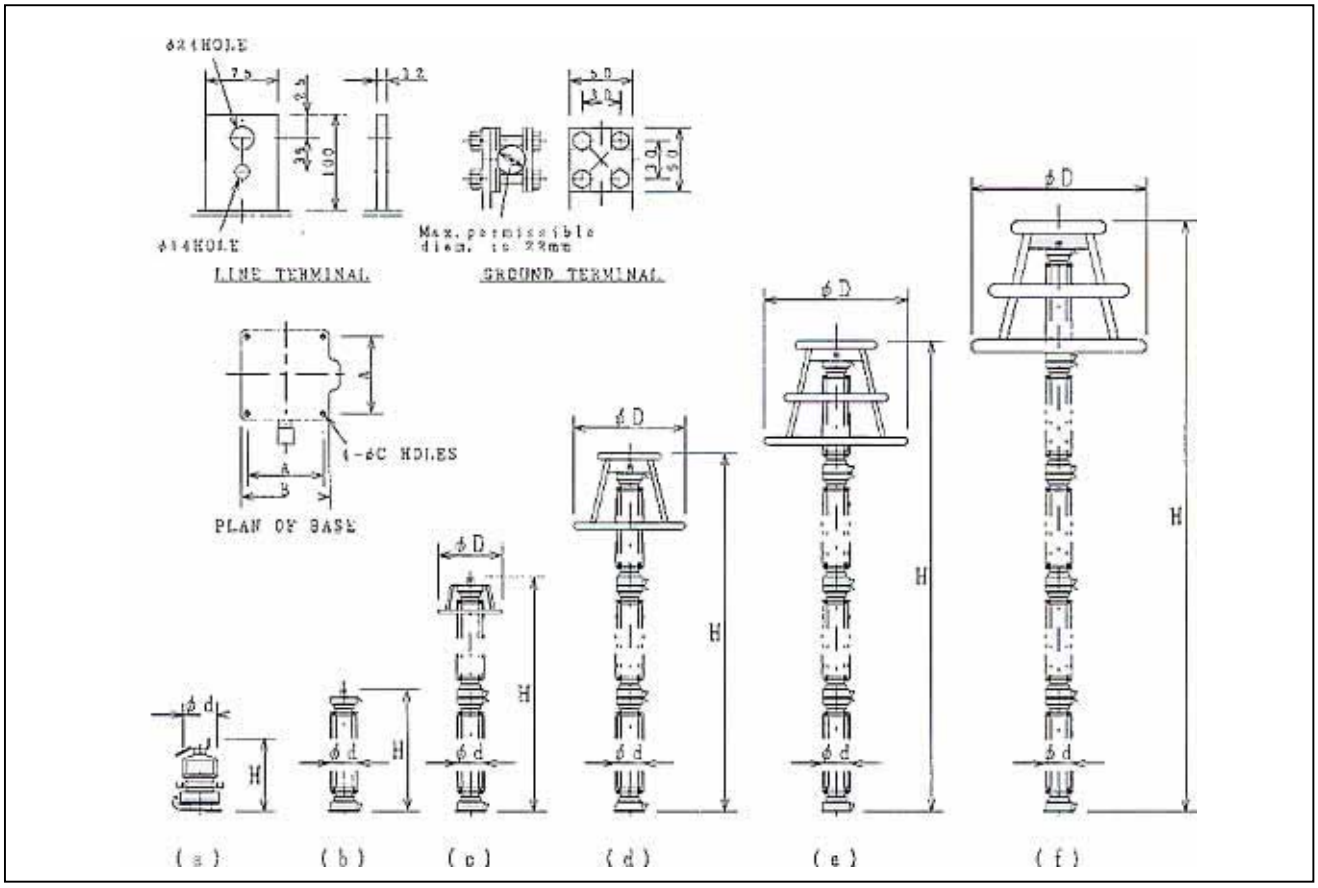

Figure 7. Outline of type RVLQD, RVLQC, RVLQB, RVLQE, RVLQA

6. Structure

Typical structure of surge arresters are shown in Figure 8 (porcelain type) and Figure 9 (GIS type). The surge arresters are basically composed of the TNR elements, housing and associated parts with insulating gas filling as shown in figures. The hermetic sealing of the housing is constructed with weather-proof synthetic rubber. The pressure relief diaphragm is structured with special metal plate, which is ruptured when a sudden pressure rise occurs in case of the internal failure. If the detailed information about the GIS type surge arrester is required, please contact us.

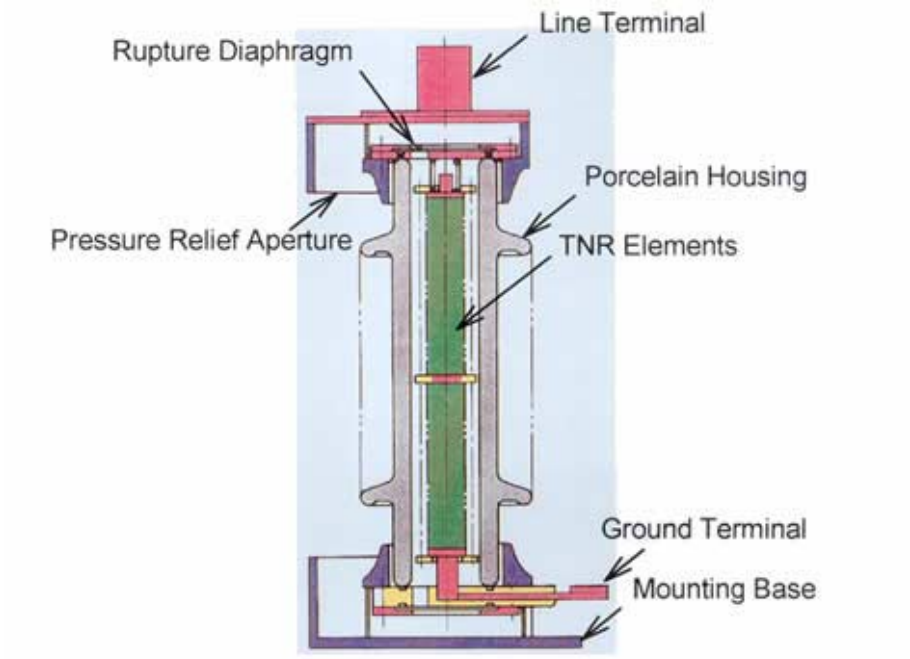

Figure 8. Typical Structure of Porcelain Type Surge Arrester

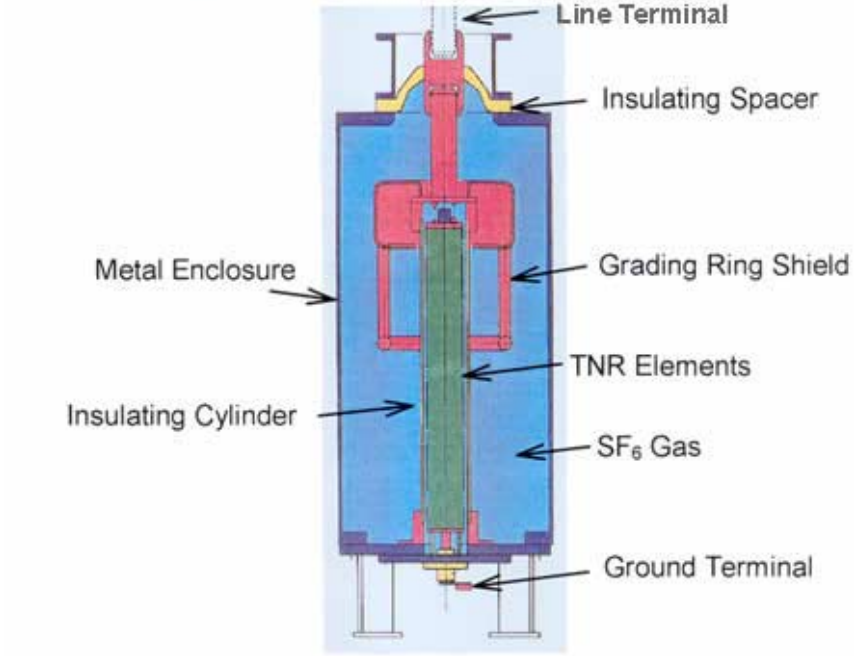

Figure 9. Typical Structure of GIS Type Surge Arrester

7. Research and Development

The development of TNR element has provided a great improvement of protective performance in surge arresters. Under continuous programs in our laboratory, research and development activities on reliability verification and optimum application technology of the TNR element are also being conducted. To realize successful commercial application of the new products, the verification of equipment reliability over a long period is indispensable. Additionally, a clear comprehension of the actual phenomena must be attained. Toshiba conducts various long-term voltage application test on actual equipment or on insulating element models, thereby contributing to equipment reliability over expanded periods of operation. Basic data accumulated by steady efforts substantiate Toshiba's equipment reliability.

After long term research and development, the following representative new products as shown in figure 10, 11 and 12 are

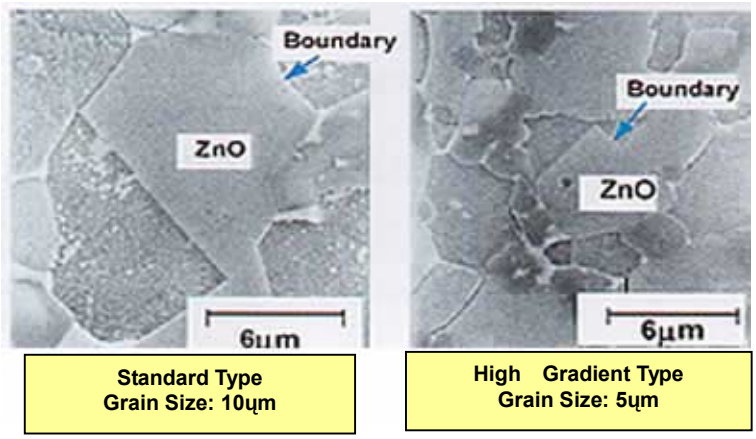

Figure 10. Conparison of Microstructure of Each TNR Element

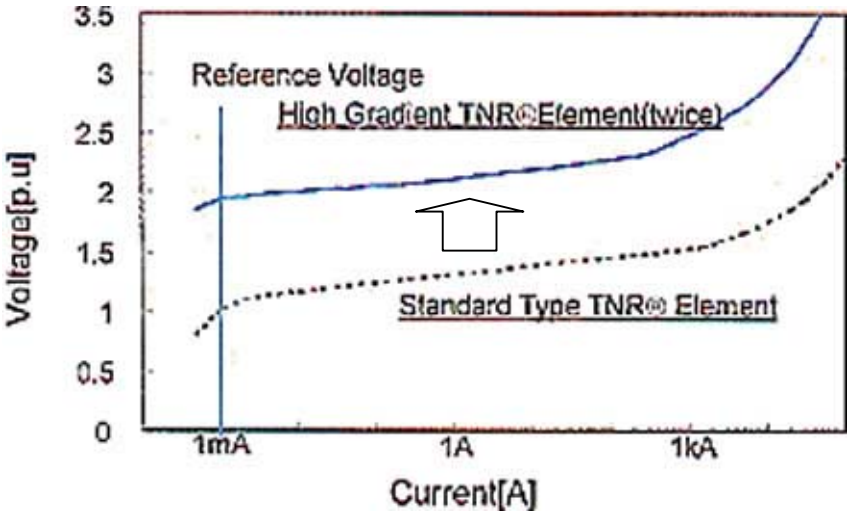

Figure 11. Comparison V-I Characteristics of Each TNR Element

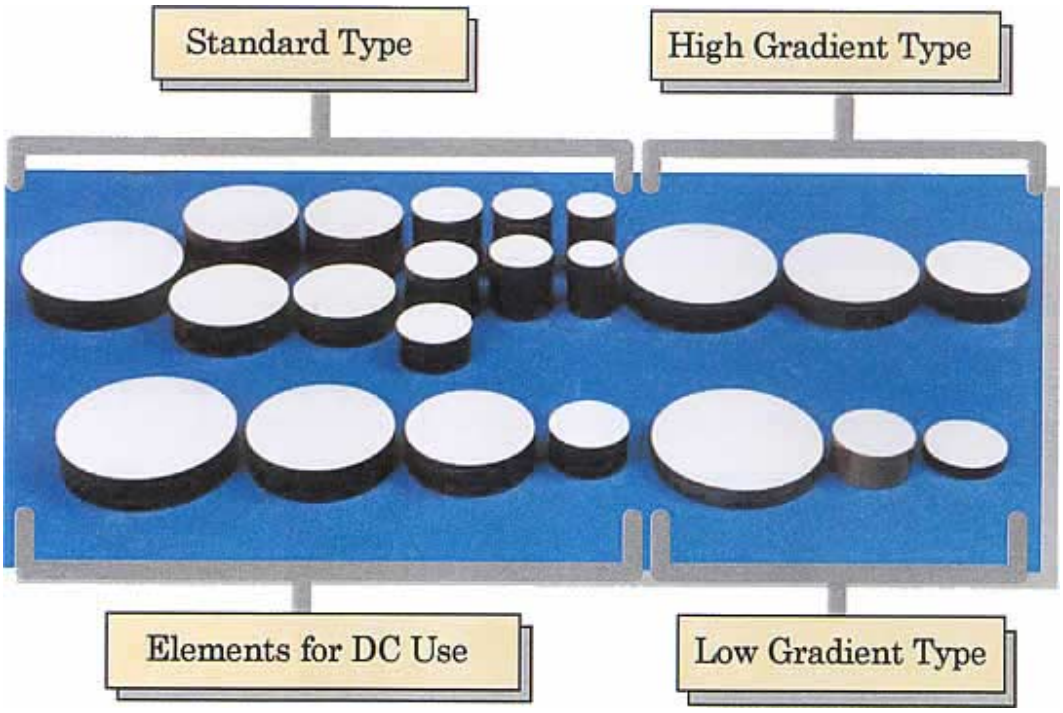

Figure12. Variation of TNR Elements used for 3.3- 1000kV and Various Type Surge Arrester

Various size and series TNR elements can be prepared for customer's special requirements, considering the technical and economical requests such as high-energy durability for special application.

8. Maintenance

Toshiba recommend the following maintenance work be carefully effected:

- Leakage Current Measurement
- Insulating Resistance Measurement
- Outer Visual Inspection

The surge arrester have a possibility to lead into a failure by extremely heavy lightnings, which are supposed as over duty, therefore the maintenance work should be done at the fine day. The measured value should be

9. Accessories

The following special accessories can be supplied upon the customer's request:

- Surge Counter
- Surge Current recorder
- Leakage Current Measurement Device

OUTLINE OF SURGE COUNTER

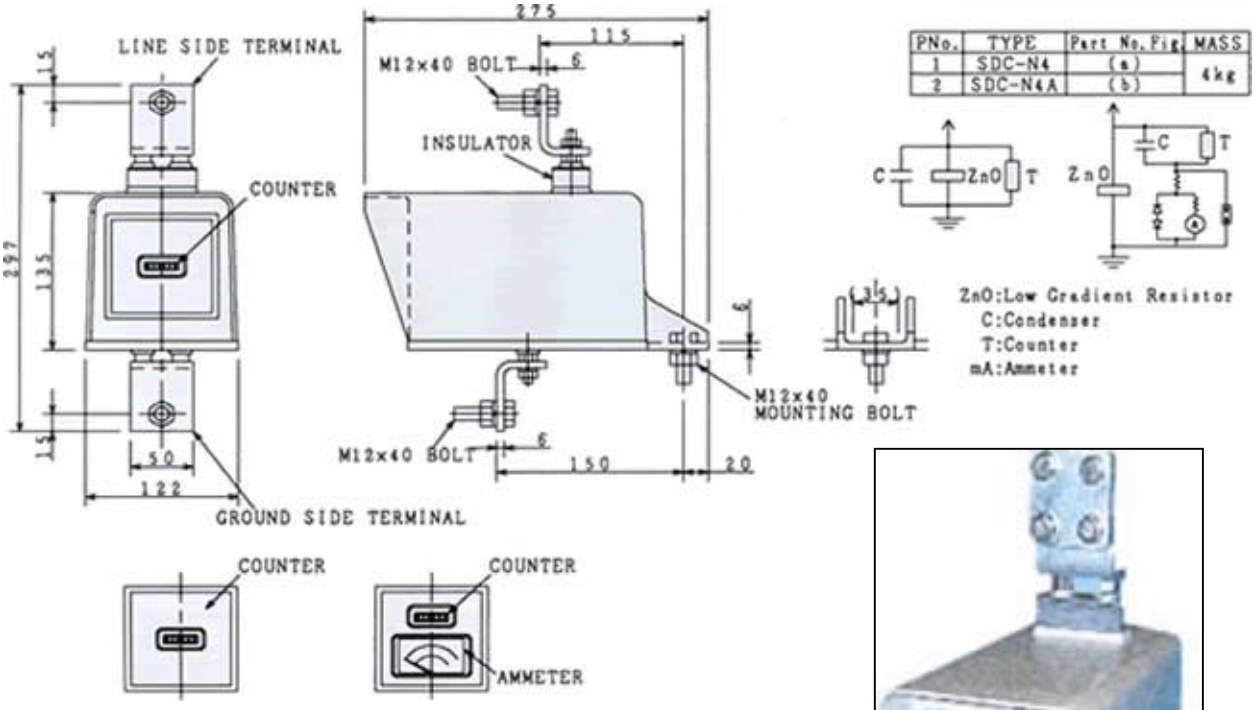

Fig. (a) Fig. (B)

Performance	
Indication of Counter	: 6 digit cyclometer at least 5
Minimum Operating Current	: 20A(8/20 us)
Maximum High Current Withstand Capability	: 100kA(4/10 us)
Residual Voltage at 1OOkA(4/10 us)	: 5kV peak and below
Switching Impulse Current Withstand	: 4000A x 2ms
Ammeter scale	: 0-5mA rms(linear scale)

10. Designating Specifications When Placing an Order

It is recommended that specifications are checked by using the type selecting check sheet below and attaching this sheet to your order sheet:

Type selecting check list DATE: FILLED BY:

CUSTOMER / COUNTRY:	SITE LOCATION / INSTALLED AT:
DELIVERY DATE:	
STANDARD: IEC ANSI OTHERS( )	
INSTALLATION:	
AMBIENT CONDITION: DUSTY SALTY FLYASH OTHERS( )	
REQUIREMENT FOR EARTH QUAKE:	

SYSTEM MAX. VOLTAGE [kV]				
SYSTEM NOMINAL VOLTAGE [kV]				
NEUTRAL EARTHING CONDITION				
RATED VOLTAGE [kV]				
RATED FREQUENCY [Hz]				
LINE DISCHARGE CLASS				
NOMINAL DISCHARGE CURRENT [kA]				
RESIDUAL VOLTAGE [kV]	at 5kA			
	at 10kA			
	at 20kA			
WITHSTAND VOLTAGE [kV]	POWER FREQUENCY			
	L. I. W. L.			
	S. I. W. L.			
CREEPAGE DISTANCE [mm]				

Fill number in each columns or place check mark (✓) in solid-line rectangle. Should no marking be given, Toshiba's standard items will be supplied.

11. General Introduction of Hamakawasaki Works

Established **:1962**
Location **: Kawasaki**

Main Products:

- **Transformers**
- **Switchgears**
- **Surge Arresters**
- **Lasers**
- **Monitoring Systems**
- **CAD Software**

TOSHIBA

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