EXHIBIT A

250 [9.84]

190 [7.48]

HYUNDAI

AUTOTRANSFORMER

TYPE NO. :	TL - 2363	NUMBER OF PHASES	3 (THREE)
RATED FREQUENCY	60 Hz	TEMP RISE (OIL/WINDING)	65/65 °C
VECTOR GROUP	YNa0d1	COOLING METHOD	ONAN/ONAF/ONAF

WINDING	RATED LOAD	RATED VOLTAGE	RATED CURRENT	BIL(LINE/NEU)	SIL
HV	403/535/672 MVA	345Y/199.2 kV	674/895/1125 A	1050/150 kV	870 kV
LV	403/535/672 MVA	138Y/79.7 kV	1686/2238/2811 A	650/150 kV	- kV
TV	84.6/112.8/141 MVA	13.2 kV	3700/4934/6167 A	150 kV	- kV

IMPEDANCE AT RATED VOLTAGE & 85 °C		
HV - XV	7.952 %	AT 403 MVA
SOUND LEVEL (ONAN/ONAF/ONAF)		72.3/ - - /76.0 dB
TYPE OF INSULATION OIL		ASTM D3487
MANUFACTURER SERIAL NO.		20120871TKE001
INSTRUCTION MANUAL		M1302028 - 20120871TKE001
YEAR AND MONTH OF MANUFACTURE		2013.FEB
P.O NUMBER OF AE		CTM MAX 1983S

APPROXIMATE WEIGHT (lbs)		
CORE & COIL ASSEMBLY		461700
UNTANKING		517750
TANK & FITTINGS		197750
INSULATION LIQUID	(30674 gal)	230360
CELLULOSE WEIGHT		27612
TOTAL. FULLY ASSEMBLED		889810
SHIPPING (WITHOUT OIL)		591400

1. CONTAINS NO DETECTABLE LEVEL OF PCB (LESS THAN 1 ppm) AT THE TIME OF MANUFACTURE
2. TANK & CONSERVATOR & REDIATOR TO WITHSTAND FULL VACUUM AND 14.7 psi POSITIVE PRESSURE
3. PRESSURE RELIEF DEVICE OPERATES AT 10 psi
4. READ INSTRUCTION BOOK BEFORE INSTALLING OR OPERATING TRANSFORMER
5. TRANSFORMER IS SUITABLE FOR STEP - UP & DOWN OPERATION
6. THE MAXIMUM COMMON WINDING CURRENT IS 2067A.

* NOTE

1. MATERIAL : STAINLESS STEEL
2. THICKNESS : 1.0 mm [0.039 in]
3. NATURAL FACE, DARK LETTER AND LINE
4. STANDARD : IEEEI C57.12.00
5. THE BLANK SPACES WILL BE ENGRAVED AFTER FACTORY TESTING

APP	H.O.SONG	1	APP	H.O.SONG	2	APP		3	DSN	CHK	APP	PROJ.	3RD	TITLE : 3PH 60HZ 400/530/672MVA 345/138/13.2KV RATING PLATE		
CHK	J.H.KANG	Revised by DRM comments	CHK	J.H.KANG	Added test value	CHK			12.06.31	12.06.31	12.06.31	UNIT	INCH			
DSN	12.08.19 E.S.SHIN		DSN	13.02.26 E.S.SHIN		DSN			E.S.SHIN	J.H KANG	H.O.SONG	SCALE	1/1	PROJECT NO.	20120871TKE001	
												SIZE	A3	CAD NO.	-	SHEET 1 / 2
									HYUNDAI HEAVY INDUSTRIES CO., LTD.					REF. NO.	-	
														DWG. NO.	TL2363 - A11	REV. 2

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.
ELECTRO ELECTRIC SYSTEMS

Address : 1000, Bangeojinsunhwan-doro, Dong-gu, Ulsan, Korea. Tel : (052) 202-8295

CERTIFICATE OF CONFORMANCE

Ref. No. : **PAC-TR-13062** Issued Date : Mar. 04, 2013

Customer : AUSTIN ENERGY

Project Name : DUNLAP SUBSTATION

Contract No. : -

Item(s) : Oil-immersed Transformer
3Φ, 403/535/672 MVA 345/138/13.2 kV, 60Hz, 1Set
Serial No. : 20120871TKE001

This is to certify that this equipment has been duly inspected and tested prior to shipment in accordance with customer's requirements.
Its mechanical, electrical and operational performances were found to be conforming to or better than the purchase order specification.
A copy of this test certificate is on file at Electro Electric Systems (Division) and available for review any time.

Certified By :

J. H. Park / General Manager
Transformer Laboratory
Product Assurance Dep't

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

HEAD OFFICE
1000, Bangeojinsunhwan-doro, Dong-gu, Ulsan, Korea
Tel. : (052) 202-8295

Customer	:	AUSTIN ENERGY
Project Name	:	AUSTIN ENERGY / DUNLAP
Contract No.	:	
Serial No.	:	20120871TKE001

INSPECTION & TEST REPORT

3Ph, 60Hz, YNa0d1
403/535/672MVA, 345/138/13.2kV

Approved by : Jae H. Park

Checked by : Man G. Cheong

Tested by : Chang W. Park

Witnessed by :

James B Templeton

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

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HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Final Test Summary List

Serial No. 20120871TKE001

Description	Unit	Guarantee Value	Tolerance	Measured Value/Result
1. Construction & dimension		Approved Spec. & dwg.		Satisfied
2. Winding resistance at 85℃				
a) HV winding (rated tap No. 3)				
- H1 - X1	Ω	-	-	0.1425584
- H2 - X2	Ω	-	-	0.1424131
- H3 - X3	Ω	-	-	0.1423830
b) LV winding (rated tap No. 1L)				
- X1 - H0X0	Ω	-	-	0.0409581
- X2 - H0X0	Ω	-	-	0.0409284
- X3 - H0X0	Ω	-	-	0.0405684
c) TV winding				
- Y1 - Y2	Ω	-	-	0.0036406
- Y2 - Y3	Ω	-	-	0.0036500
- Y3 - Y1	Ω	-	-	0.0036786
3. Turns ratio				
a) HV - LV winding	%	± 0.5	-	-0.19~0.24
b) HV - TV winding	%	± 0.5	-	0.24~0.33
c) LV - TV winding	%	± 0.5	-	0.00~0.47
4. Polarity & phase relationship	-	YNa0d1	-	YNa0d1
5. Insulation resistance at 22℃ (1.0min.)				
a) HV,LV winding to earth	MΩ	≥ 800	-	6510
b) TV winding to earth	MΩ	≥ 800	-	30700
c) HV,LV winding to TV winding	MΩ	≥ 800	-	8950
d) Main core to earth (1000V megger)	MΩ	-	-	2000
e) Serial T/R core to earth (1000V megger)	MΩ	-	-	2000
6. Insulation power factor at 20℃				
a) HV,LV - earth (C_H)	%	0.5	-	0.321
b) TV - earth (C_T)	%	0.5	-	0.244
c) HV,LV - TV (C_{HT})	%	0.5	-	0.145
7. No-load losses, at Tap position 3 / 16R (Before / after impulse test)				
a) 100% rated voltage(20℃)	kW	110.0	-	104.709/105.536
b) 110% rated voltage(20℃)	kW	-	-	131.550/132.647
8. Exciting current at ONAN rating 403MVA base (Before / after impulse test)				
a) 100% rated voltage(20℃)	%	-	-	0.035/0.035
b) 110% rated voltage(20℃)	%	-	-	0.038/0.038

Date of Test : 2013. 02. 26 | Tested by : C. W. Park

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Final Test Summary List

Serial No. 20120871TKE001

Description	Unit	Guarantee Value	Tolerance	Measured Value/Result
9. Sound level (Tap position 5/16L)				
a) Without cooling system(403MVA base)	dB	77.0	-	72.3
b) With cooling system(672MVA base)	dB	80.0	-	76.0
10. Percent impedance at 85℃				
a) HV - LV side at ONAN rating 403MVA base				
- at Max. tap position (DETC-1 / LTC-16R)	%	-	-	8.942
- at Rated tap position (DETC-3 / LTC-1L)	%	8.0	± 10%	7.952
- at Min. tap position (DETC-5 / LTC-16L)	%	-	-	7.523
b) HV - TV side at ONAN rating 84.6MVA base				
- at Max. tap position (DETC-1 / LTC-1L)	%	-	-	12.020
- at Rated tap position (DETC-3 / LTC-1L)	%	-	-	11.763
- at Min. tap position (DETC-5 / LTC-1L)	%	-	-	11.711
c) LV - TV side at 84.6MVA base				
- at Rated tap position (DETC-3 / LTC-1L)	%	-	-	9.623
11. Zero sequence impedance, at rated tap position (DETC-3 / LTC-1L)				
a) HV - LV side at 403MVA base	%	-	-	7.953
b) HV - TV side at 84.6MVA base	%	-	-	9.098
c) LV - TV side at 84.6MVA base	%	-	-	11.097
12. Load losses at 85℃				
a) HV - LV side at ONAN rating 403MVA base				
- at Max. tap position (DETC-1 / LTC-16R)	kW	-	-	434.009
- at Rated tap position (DETC-3 / LTC-1L)	kW	460.0	-	434.751
- at Min. tap position (DETC-5 / LTC-16L)	kW	-	-	525.142
b) HV - TV side at ONAN rating 84.6MVA base				
- at Max. tap position (DETC-1 / LTC-1L)	kW	-	-	119.816
- at Rated tap position (DETC-3 / LTC-1L)	kW	-	-	120.333
- at Min. tap position (DETC-5 / LTC-1L)	kW	-	-	121.916
c) LV - TV side at ONAN rating 84.6MVA base				
- at Rated tap position (DETC-3 / LTC-1L)	kW	-	-	118.494
13. Auxiliary losses (Cooling fan)				
a) Total (32) fans	kW	13.0	-	7.480

Date of Test : 2013. 02. 26 | Tested by : C. W. Park

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Final Test Summary List

Serial No. 20120871TKE001

Description	Unit	Guarantee Value	Tolerance	Measured Value/Result
14. Efficiency at ONAN rating 403MVA base, at 85℃, rated tap position (DETC-3 / LTC-1L)				
a) at 100% load 1.0 power factor	%	-	-	99.866
b) at 75% load 1.0 power factor	%	-	-	99.885
c) at 50% load 1.0 power factor	%	-	-	99.894
d) at 25% load 1.0 power factor	%	-	-	99.869
15. Voltage regulation at ONAN rating 403MVA base, at 85℃, rated tap position (DETC-3 / LTC-1L)				
a) at 1.0 power factor	%	-	-	0.424
b) at 0.9 power factor	%	-	-	3.816
c) at 0.8 power factor	%	-	-	5.055
16. Temperature rise, tap position (DETC-1 / LTC-16L)				
a) HV-LV side ONAN rating 403MVA base				
- Top oil temperature	K	65.0	-	48.50
- Average HV winding temperature (H2-X2)	K	65.0	-	45.28
- Average LV winding temperature (X2-H0X0)	K	65.0	-	47.07
- Hotspot HV winding temperature (H2-X2)	K	80.0	-	58.87
- Hotspot LV winding temperature (X2-H0X0)	K	80.0	-	61.20
b) HV-LV side ONAF2 rating 672MVA base				
- Top oil temperature	K	65.0	-	55.87
- Average HV winding temperature (H2-X2)	K	65.0	-	51.87
- Average LV winding temperature (X2-H0X0)	K	65.0	-	54.21
- Hotspot HV winding temperature (H2-X2)	K	80.0	-	73.81
- Hotspot LV winding temperature (X2-H0X0)	K	80.0	-	76.85
c) HV-TV side ONAF2 rating 5MVA base				
- Average TV winding temperature (Y2-Y3)	K	65.0	-	52.62
- Hotspot TV winding temperature (Y2-Y3)	K	80.0	-	74.79

Date of Test : 2013. 02. 26 | Tested by : C. W. Park

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Technical Data

Serial No. 20120871TKE001

Description	Unit	Guarantee Value	Tolerance	Measured Value/Result
1. Lightning impulse voltage test				
a) HV winding	kV	1050.0	-	**Withstood**
b) LV winding	kV	650.0	-	**Withstood**
c) HV & LV Neutral	kV	150.0	-	**Withstood**
d) TV winding	kV	150.0	-	**Withstood**
2. Switching impulse voltage test				
a) HV winding	kV	870.0	-	**Withstood**
3. Applied voltage withstand test				
a) HV,LV & neutral to TV,earth	kV	50.0	-	**Withstood**
b) TV to HV,LV & neutral,earth	kV	50.0	-	**Withstood**
4. Induced overvoltage withstand test between HV phase to ground voltage (Tap No.1 / 16R)				
a) Enhancement level-U_1(7200cycles)	kV	365/150	-	**Withstood**
b) 60 minutes level - U_2	kV	315/132	-	**Withstood**
c) R.I.V (HV / LV) - U_2 (60min.max.value)	μV	50.0	-	**75.0/82.0**
c) P.D (HV / LV) - U_2 (60min.max.value)	pC	300.0	-	**39.0/29.0**
5. Over execitation test (110% rated voltage)		24hours	-	**Passed**
6. Oil leakage test		0.35kg/cm², 14hours		**Passed**
7. Control panel test (with BCT)				
a) operation test		-	-	**Passed**
b) Auxiliary device check		-	-	**Passed**
c) B.C.T check		-	-	**Passed**
d) AVR check		-	-	**Passed**
8. Dissolved Gas-in-oil analysis				**Passed**

Date of Test : 2013. 02. 26	Tested by : C. W. Park

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Turns Ratio Measurement

Serial No.
20120871TKE001

Tap Voltage				Rated Ratio	Measurement Value					
HV		LV			H1-H0X0 / X1-H0X0		H2-H0X0 / X2-H0X0		H3-H0X0 / X3-H0X0	
No.	Voltage	No.	Voltage		Ratio	%Error	Ratio	%Error	Ratio	%Error
1	362250	1L	138070	2.6237	2.6285	0.18	2.6285	0.18	2.6288	0.20
2	353625	1L	138121	2.5603	2.5663	0.24	2.5646	0.17	2.5660	0.22
3	345000	1L	138175	2.4968	2.5013	0.18	2.5003	0.14	2.5010	0.17
4	336375	1L	138232	2.4334	2.4371	0.15	2.4365	0.13	2.4372	0.16
5	327750	1L	138292	2.3700	2.3725	0.11	2.3730	0.13	2.3730	0.13

Date of Test : 2013. 02. 21

Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Turns Ratio Measurement

Serial No.
20120871TKE001

Tap Voltage				Rated Ratio	Measurement Value					
HV		LV			H1-H0X0 / X1-H0X0		H2-H0X0 / X2-H0X0		H3-H0X0 / X3-H0X0	
No.	Voltage	No.	Voltage		Ratio	%Error	Ratio	%Error	Ratio	%Error
3	345000	16R	152062	2.2688	2.2691	0.01	2.2685	-0.01	2.2697	0.04
3	345000	15R	151297	2.2803	2.2837	0.15	2.2836	0.15	2.2836	0.15
3	345000	14R	150252	2.2961	2.2921	-0.18	2.2917	-0.19	2.2921	-0.18
3	345000	13R	149748	2.3039	2.3077	0.17	2.3072	0.14	2.3077	0.17
3	345000	12R	148965	2.3160	2.3156	-0.02	2.3150	-0.04	2.3143	-0.07
3	345000	11R	148175	2.3283	2.3327	0.19	2.3316	0.14	2.3310	0.11
3	345000	10R	147379	2.3409	2.3407	-0.01	2.3417	0.03	2.3418	0.04
3	345000	9R	146576	2.3537	2.3570	0.14	2.3556	0.08	2.3558	0.09
3	345000	8R	145767	2.3668	2.3681	0.06	2.3672	0.02	2.3683	0.06
3	345000	7R	144951	2.3801	2.3830	0.12	2.3825	0.10	2.3845	0.18
3	345000	6R	144128	2.3937	2.3935	-0.01	2.3917	-0.08	2.3931	-0.03
3	345000	5R	143299	2.4076	2.4117	0.17	2.4107	0.13	2.4120	0.18
3	345000	4R	142463	2.4217	2.4223	0.03	2.4211	-0.02	2.4223	0.03
3	345000	3R	141619	2.4361	2.4403	0.17	2.4395	0.14	2.4403	0.17
3	345000	2R	140769	2.4508	2.4507	-0.01	2.4513	0.02	2.4508	0.00
3	345000	1R	139912	2.4658	2.4706	0.19	2.4691	0.13	2.4700	0.17
3	345000	N	139047	2.4812	2.4821	0.04	2.4803	-0.04	2.4810	-0.01
3	345000	1L	138175	2.4968	2.5016	0.19	2.5000	0.13	2.5020	0.21
3	345000	2L	137296	2.5128	2.5128	0.00	2.5131	0.01	2.5141	0.05
3	345000	3L	136409	2.5292	2.5333	0.16	2.5326	0.14	2.5331	0.16
3	345000	4L	135515	2.5458	2.5478	0.08	2.5456	-0.01	2.5461	0.01
3	345000	5L	134612	2.5629	2.5672	0.17	2.5665	0.14	2.5683	0.21
3	345000	6L	133702	2.5804	2.5816	0.05	2.5808	0.02	2.5816	0.05
3	345000	7L	132785	2.5982	2.6027	0.17	2.6025	0.17	2.6031	0.19
3	345000	8L	131859	2.6164	2.6178	0.05	2.6168	0.01	2.6181	0.06
3	345000	9L	130925	2.6351	2.6407	0.21	2.6387	0.14	2.6387	0.14
3	345000	10L	129982	2.6542	2.6541	0.00	2.6537	-0.02	2.6562	0.07
3	345000	11L	129032	2.6738	2.6777	0.15	2.6772	0.13	2.6783	0.17
3	345000	12L	128073	2.6938	2.6947	0.03	2.6927	-0.04	2.6945	0.03
3	345000	13L	127105	2.7143	2.7196	0.20	2.7187	0.16	2.7183	0.15
3	345000	14L	126129	2.7353	2.7366	0.05	2.7360	0.03	2.7363	0.04
3	345000	15L	125144	2.7568	2.7618	0.18	2.7616	0.17	2.7626	0.21
3	345000	16L	124150	2.7789	2.7802	0.05	2.7795	0.02	2.7800	0.04

Date of Test : 2013. 02. 21 | Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Turns Ratio Measurement

Serial No.
20120871TKE001

Tap Voltage				Rated Ratio	Measurement Value					
HV		TV			H1-H2.H3 / Y1-Y2		H2-H3.H1 / Y2-Y3		H3-H1.H2 / Y3-Y1	
No.	Voltage	No.	Voltage		Ratio	%Error	Ratio	%Error	Ratio	%Error
1	362250	-	13145	15.9106	15.9560	0.29	15.9550	0.28	15.9540	0.27
2	353625	-	13150	15.5259	15.5630	0.24	15.5650	0.25	15.5660	0.26
3	345000	-	13155	15.1415	15.1810	0.26	15.1780	0.24	15.1840	0.28
4	336375	-	13161	14.7562	14.8000	0.30	14.7980	0.28	14.7960	0.27
5	327750	-	13167	14.3713	14.4130	0.29	14.4130	0.29	14.4190	0.33

※ LV Tap :1L Y-D

Date of Test : 2013. 02. 21 | Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Turns Ratio Measurement

Serial No.
20120871TKE001

Tap Voltage				Rated Ratio	Measurement Value					
LV		TV			X1-H0X0 / Y1-Y2		X2-H0X0 / Y2-Y3		X3-H0X0 / Y3-Y1	
No.	Voltage	No.	Voltage		Ratio	%Error	Ratio	%Error	Ratio	%Error
16R	152062	-	12272	7.1539	7.1610	0.10	7.1550	0.01	7.1600	0.08
15R	151297	-	12321	7.0896	7.1170	0.39	7.1120	0.32	7.1160	0.37
14R	150252	-	12370	7.0128	7.0310	0.26	7.0280	0.22	7.0290	0.23
13R	149748	-	12419	6.9617	6.9880	0.38	6.9820	0.29	6.9860	0.35
12R	148965	-	12469	6.8975	6.9050	0.11	6.8990	0.02	6.9040	0.09
11R	148175	-	12519	6.8335	6.8590	0.37	6.8550	0.31	6.8610	0.40
10R	147379	-	12570	6.7692	6.7770	0.11	6.7740	0.07	6.7750	0.09
9R	146576	-	12621	6.7051	6.7300	0.37	6.7270	0.33	6.7310	0.39
8R	145767	-	12673	6.6408	6.6470	0.09	6.6430	0.03	6.6460	0.08
7R	144951	-	12724	6.5771	6.6030	0.39	6.5970	0.30	6.6000	0.35
6R	144128	-	12777	6.5127	6.5180	0.08	6.5140	0.02	6.5170	0.07
5R	143299	-	12830	6.4485	6.4760	0.43	6.4710	0.35	6.4750	0.41
4R	142463	-	12883	6.3845	6.3930	0.13	6.3860	0.02	6.3880	0.06
3R	141619	-	12936	6.3206	6.3480	0.43	6.3440	0.37	6.3470	0.42
2R	140769	-	12990	6.2566	6.2610	0.07	6.2580	0.02	6.2620	0.09
1R	139912	-	13045	6.1923	6.2200	0.45	6.2140	0.35	6.2200	0.45
N	139047	-	13100	6.1282	6.1360	0.13	6.1310	0.05	6.1350	0.11
1L	138175	-	13155	6.0643	6.0900	0.42	6.0870	0.37	6.0910	0.44
2L	137296	-	13211	6.0001	6.0090	0.15	6.0000	0.00	6.0040	0.06
3L	136409	-	13268	5.9358	5.9630	0.46	5.9600	0.41	5.9610	0.43
4L	135515	-	13325	5.8716	5.8810	0.16	5.8770	0.09	5.8750	0.06
5L	134612	-	13382	5.8077	5.8340	0.45	5.8290	0.37	5.8350	0.47
6L	133702	-	13440	5.7435	5.7490	0.10	5.7470	0.06	5.7500	0.11
7L	132785	-	13498	5.6796	5.7050	0.45	5.7030	0.41	5.7050	0.45
8L	131859	-	13557	5.6155	5.6200	0.08	5.6180	0.05	5.6200	0.08
9L	130925	-	13617	5.5511	5.5770	0.47	5.5730	0.39	5.5760	0.45
10L	129982	-	13677	5.4870	5.4939	0.13	5.4903	0.06	5.4941	0.13
11L	129032	-	13737	5.4231	5.4482	0.46	5.4441	0.39	5.4481	0.46
12L	128073	-	13798	5.3590	5.3641	0.10	5.3615	0.05	5.3663	0.14
13L	127105	-	13860	5.2947	5.3190	0.46	5.3181	0.44	5.3180	0.44
14L	126129	-	13922	5.2306	5.2365	0.11	5.2305	0.00	5.2373	0.13
15L	125144	-	13984	5.1668	5.1899	0.45	5.1885	0.42	5.1901	0.45
16L	124150	-	14048	5.1024	5.1085	0.12	5.1049	0.05	5.1063	0.08

※ HV Tap :3

Date of Test : 2013. 02. 21 | Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Measurement

Serial No.
20120871TKE001

Tap No. (HV)	Tap Voltage (V)	High voltage side in ohms					
		H1 - X1		H2 - X2		H3 - X3	
		at 22.0 ℃	at 85 ℃	at 22.0 ℃	at 85 ℃	at 22.0 ℃	at 85 ℃
1	362250	0.1249022	0.1555799	0.1247599	0.1554027	0.1247610	0.1554040
2	353625	0.1196655	0.1490570	0.1195434	0.1489049	0.1195302	0.1488885
3	345000	0.1144483	0.1425584	0.1143317	0.1424131	0.1143075	0.1423830
4	336375	0.1092648	0.1361017	0.1091520	0.1359612	0.1091134	0.1359132
5	327750	0.1040834	0.1296478	0.1039766	0.1295147	0.1039184	0.1294422

Tap No. (TV)	Tap Voltage (V)	Tertiary voltage side in ohms					
		Y1 - Y2		Y2 - Y3		Y3 - Y1	
		at 22.0 ℃	at 85 ℃	at 22.0 ℃	at 85 ℃	at 22.0 ℃	at 85 ℃
-	13200	0.0029228	0.0036406	0.0029303	0.0036500	0.0029533	0.0036786

Date of Test : 2013. 02. 21	Tested by : I. D. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Measurement

Serial No.
20120871TKE001

Tap No. (LV)	Tap Voltage (V)	Low voltage side in ohms					
		X1 - H0X0		X2 - H0X0		X3 - H0X0	
		at 22.0 ℃	at 85 ℃	at 22.0 ℃	at 85 ℃	at 22.0 ℃	at 85 ℃
16R	152062	0.0387254	0.0482369	0.0384744	0.0479243	0.0380093	0.0473449
15R	151297	0.0380315	0.0473726	0.0378490	0.0471453	0.0374448	0.0466418
14R	150252	0.0380623	0.0474109	0.0378125	0.0470998	0.0373538	0.0465284
13R	149748	0.0373653	0.0465428	0.0371814	0.0463136	0.0367794	0.0458129
12R	148965	0.0373986	0.0465843	0.0371464	0.0462700	0.0366806	0.0456898
11R	148175	0.0367038	0.0457187	0.0365181	0.0454875	0.0361142	0.0449843
10R	147379	0.0367374	0.0457606	0.0364857	0.0454471	0.0360155	0.0448614
9R	146576	0.0360506	0.0449051	0.0358656	0.0446747	0.0354679	0.0441793
8R	145767	0.0361142	0.0449844	0.0358633	0.0446719	0.0354095	0.0441066
7R	144951	0.0353981	0.0440923	0.0352105	0.0438587	0.0348170	0.0433686
6R	144128	0.0354639	0.0441743	0.0352110	0.0438593	0.0347536	0.0432895
5R	143299	0.0347258	0.0432549	0.0345406	0.0430242	0.0341510	0.0425390
4R	142463	0.0347840	0.0433274	0.0345279	0.0430084	0.0340835	0.0424549
3R	141619	0.0340577	0.0424228	0.0338675	0.0421858	0.0334814	0.0417049
2R	140769	0.0341218	0.0425026	0.0338668	0.0421850	0.0334145	0.0416216
1R	139912	0.0328960	0.0409757	0.0328725	0.0409464	0.0325928	0.0405981
N	139047	0.0326014	0.0406087	0.0326269	0.0406406	0.0323780	0.0403305
1L	138175	0.0328819	0.0409581	0.0328580	0.0409284	0.0325690	0.0405684
2L	137296	0.0340025	0.0423540	0.0337353	0.0420212	0.0332612	0.0414306
3L	136409	0.0339736	0.0423180	0.0337775	0.0420737	0.0333614	0.0415554
4L	135515	0.0346663	0.0431808	0.0344056	0.0428560	0.0339316	0.0422656
5L	134612	0.0346323	0.0431385	0.0344430	0.0429027	0.0340236	0.0423802
6L	133702	0.0353308	0.0440086	0.0350626	0.0436744	0.0345817	0.0430754
7L	132785	0.0352969	0.0439663	0.0351011	0.0437224	0.0346830	0.0432016
8L	131859	0.0359912	0.0448311	0.0357253	0.0444999	0.0352409	0.0438966
9L	130925	0.0359676	0.0448017	0.0357764	0.0445635	0.0353572	0.0440414
10L	129982	0.0367047	0.0457198	0.0364417	0.0453923	0.0359667	0.0448006
11L	129032	0.0366519	0.0456541	0.0364622	0.0454178	0.0360457	0.0448990
12L	128073	0.0373815	0.0465630	0.0371266	0.0462455	0.0366465	0.0456473
13L	127105	0.0373175	0.0464831	0.0371327	0.0462530	0.0367109	0.0457277
14L	126129	0.0380345	0.0473763	0.0377798	0.0470590	0.0373099	0.0464738
15L	125144	0.0379831	0.0473123	0.0377978	0.0470815	0.0373786	0.0465593
16L	124150	0.0387164	0.0482257	0.0384668	0.0479148	0.0379835	0.0473128

Date of Test : 2013. 02. 21 | Tested by : I. D. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Polarity & phase relationship

Serial No. 20120871TKE001

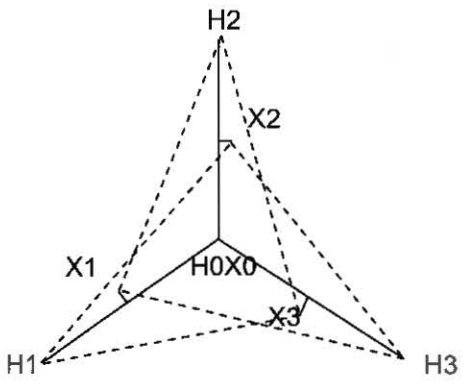
1) HV-LV Side

Tap position : 3 / 1L

HV		LV	
Phase	Voltage(V)	Phase	Voltage(V)
H1-H2	223.0	X1-X2	89.3
H2-H3	223.6	X2-X3	89.5
H3-H1	223.4	X3-X1	89.7

Vector	H1-X2	161.2	(V)
	H1-X3	161.6	(V)
	H2-X1	161.1	(V)
	H2-X3	161.1	(V)
	H3-X1	161.3	(V)
	H3-X2	161.5	(V)

Vector Diagram



YNa0

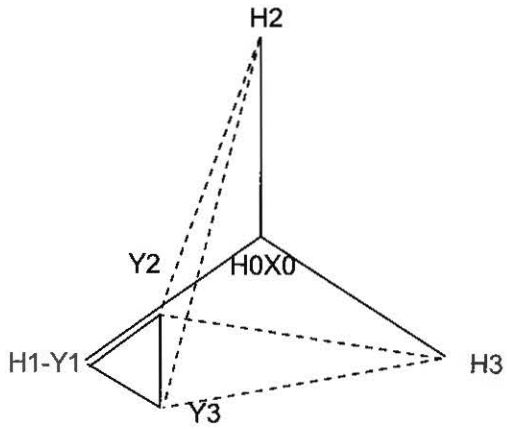
2) HV-TV Side

Tap position : 3 / 1L

HV		TV	
Phase	Voltage(V)	Phase	Voltage(V)
H1-H2	223.7	Y1-Y2	8.5
H2-H3	224.1	Y2-Y3	8.5
H3-H1	224.4	Y3-Y1	8.5

Vector	H2-Y2	216.4	(V)
	H2-Y3	223.8	(V)
	H3-Y2	216.7	(V)
	H3-Y3	217.1	(V)

Vector Diagram



YNd1

Date of Test : 2013. 02. 21

Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Insulation Resistance Measurement

Serial No.
20120871TKE001

1. Winding insulation resistance measurement

-. 5000V, 5000GΩ Meter at 22 ℃. (Unit : MΩ)

	1 (min.)			
HV,LV - Earth (TV-Guard)	6510			
TV - Earth (HV,LV-Guard)	30700			
HV,LV - TV (Tank-Guard)	8950			

2. Core & Clamp insulation resistance measurement

-. 1000V, 2000MΩ Meter at 22 ℃. (Unit : MΩ)

	Core - Earth	Clamp - Earth	Core - Clamp
1 (min.)	2000	2000	2000

3. Reactor Core & Clamp insulation resistance measurement

-. 1000V, 2000MΩ Meter at 22 ℃. (Unit : MΩ)

	Core - Earth	Clamp - Earth	Core - Clamp
1 (min.)	2000	2000	2000

Date of Test : 2013. 02. 21	Tested by : C. S. Ha

AUSTIN 20120971TKE001.txt

Nameplate

Date (YY/MM/DD)	13/02/21	Time	01:46 PM
Company	AUSTIN / DUNLAP		
Location	3PH 403/535/672MVA 345/138/13.2kV		
Equipment			
Serial Number	20120871TKE001		
Manufacturer			
Special ID	2TKE001		
Circuit Designation			

Test Conditions

Weather	Indoors	Air Temperature	18 ℃
Humidity	42 %	Oil Temperature	22 ℃

Test Results

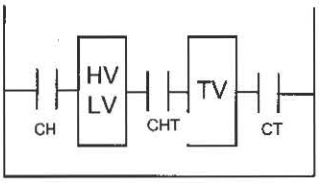
No	Test ID	L C	Circ. Desc.	kV	mA	Watts	Meas. %PF	Corr. Fctr	Corr. %PF	Cap./ Ind.	R T
1	CH+CHL		A GND-RB	10.00	111.577	2.691	0.241	0.99	0.239	29597.15 pF	
2	CH		A GAR-R	10.00	62.032	2.007	0.324	0.99	0.321	16454.85 pF	
3	CHL		A UST-R	10.00	49.330	0.721	0.146	0.99	0.145	13085.45 pF	
4	CHL+CL		A GND-RB	10.00	146.241	2.963	0.203	0.99	0.201	38793.75 pF	
5	CL		A GAR-R	10.00	96.750	2.383	0.246	0.99	0.244	25663.30 pF	
6	CH+CL		A GND-RB	10.00	158.910	4.144	0.261	0.99	0.258	42151.60 pF	
8	H1 1ZUA 1000040108	C1	A UST-R	10.00	2.132	0.067	0.316	1.01	0.319	565.61 pF	
9		C2	A GAR-R	2.000	30.477	0.924	0.303	1.01	0.306	8084.31 pF	
10	H2 1ZUA 1000040109	C1	A UST-R	10.00	2.174	0.068	0.314	1.01	0.317	576.69 pF	
11		C2	A GAR-R	2.000	31.049	0.878	0.283	1.01	0.286	8236.03 pF	
12	H3 1ZUA 1000040107	C1	A UST-R	10.00	2.129	0.066	0.312	1.01	0.315	564.78 pF	
13		C2	A GAR-R	2.000	31.106	0.923	0.297	1.01	0.300	8251.14 pF	
14	X1 1ZUA 1000060201	C1	A UST-R	10.00	1.585	0.047	0.299	1.01	0.302	420.52 pF	
15		C2	A GAR-R	2.000	17.817	0.470	0.264	1.01	0.266	4726.13 pF	
16	X2 1ZUA 1000060200	C1	A UST-R	10.00	1.585	0.047	0.296	1.01	0.299	420.38 pF	
17		C2	A GAR-R	2.000	17.056	0.455	0.267	1.01	0.269	4524.11 pF	
18	X3 1ZUA 1000060199	C1	A UST-R	10.00	1.588	0.047	0.298	1.01	0.301	421.20 pF	
19		C2	A GAR-R	2.000	17.524	0.466	0.266	1.01	0.268	4648.53 pF	
20	HOXO 1ZUA 1000039897	C1	A UST-R	10.00	2.037	0.048	0.234	1.01	0.236	540.47 pF	
21		C2	A GAR-R	0.500	1.680	0.026	0.153	1.01	0.154	445.59 pF	
22	Y11ZUA 1000032722	C1	A UST-R	10.00	2.854	0.055	0.192	1.01	0.194	757.05 pF	
23		C2	A GAR-R	0.500	2.977	0.069	0.232	1.01	0.234	789.56 pF	
24	Y21ZUA 1000032723	C1	A UST-R	10.00	2.837	0.054	0.190	1.01	0.192	752.45 pF	
25		C2	A GAR-R	0.500	2.935	0.069	0.236	1.01	0.239	778.56 pF	
26	Y31ZUA 1000032721	C1	A UST-R	10.00	2.805	0.053	0.190	1.01	0.192	743.94 pF	
27		C2	A GAR-R	0.500	2.974	0.080	0.270	1.01	0.273	788.87 pF	

LC (Line Configuration) Parameters:
A = Ref. to 10 kV, Line Frequency Modulation, 60 Hz
B = Ref. to 10 kV, Line Frequency Modulation, 50 Hz
C = Ref. to 10 kV, Line Sync Reversal
D = Actual Values, Line Frequency Modulation, 60 Hz
E = Actual Values, Line Frequency Modulation, 50 Hz
F = Actual Values, Line Sync Reversal

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of insulation power factor

Two Winding & Auto Transformer



No.	Items	Mode	Supply	Ground	Guard	Measured	Remark
1	CH+CHL	GND-RB	High	Low(Ter.)	-	-	-
2	CH	GAR-R	High	-	Low(Tertiary)	-	-
3	CHL	UST-R	High	-	-	Low(Tertiary)	-
4	CHL+CL	GND-RB	Low(Ter.)	High	-	-	-
5	CL	GAR-R	Low(Ter.)	-	High	-	or (GAR-RB)
6	CH+CL	GND-RB	High+Low(Ter.)	-	-	Ground(Tank)	or (GAR-RB)

☞1,2,3) Test ; High voltage supply, Low(Tertiary)voltage red cable (Blue cable : Not Used)

☞4,5) Test ; Low(Tertiary)voltage supply, High voltage red cable (Blue cable : Not Used)

☞6) Test ; High+Low(Tertiary)voltage supply, Measured (Tank) Ground (Red+Blue cable : Not Used)

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of No load losses and exciting current

Serial No.
20120871TKE001

※ Before Impulse test

Test frequency **60 Hz,** **19.8 ℃**

TV side connection at rated voltage **12.272 kV,** **based** **403 MVA** HV / LV Tap No. : 3 / 16R

Supply voltage/√3 (V) (Phase to Ground)			Current(A)					No load losses (W)		
			Phase			Average				
(%)	mean	rms	Ia	Ib	Ic	Io	%	P_m	$P_c(T_m)$	$P_c(T_r)$
90	6377	6363	6.490	5.110	6.640	6.080	0.032	83016	83203	83192
100	7085	7067	7.250	5.450	7.070	6.590	0.035	104450	104723	104709
105	7440	7419	7.690	5.630	7.230	6.850	0.036	117012	117347	117332
110	7794	7768	8.220	5.900	7.390	7.170	0.038	131140	131567	131550

Remark :

- **$P_c(T_r)$ is Calculated as per IEEE std C57. 12. 90-2006 Clause 8.4**
- P_m is measured no-load losses at temperature T_m
- $Pc(T_m)$ is the no-load losses, corrected for waveform, at temperature T_m
- $Pc(T_r)$ is the no-load losses, corrected to the reference temperature T_r = 20℃

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of No load losses and exciting current

Serial No. 20120871TKE001

403 MVA BASE

Test frequency at 60 Hz ※ Before Impulse test HV / LV Tap No. : 3 / 16R

TV Side Connection at rated voltage : 12.272 kV, Oil temp. : 19.8 ℃

90 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	6377 V	6393 V /	6379 V	I_1	6.490 A	P_1	32404 W
V_2	6377 V	6365 V /	6352 V	I_2	5.110 A	P_2	21919 W
V_3	6377 V	6372 V /	6357 V	I_3	6.640 A	P_3	28693 W
V_{AVG}	6377 V	6377 V /	6363 V	I_{AVG}	6.080 A	Pm	83016 W
					0.032 %	Pc	83203 W

100 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	7085 V	7104 V /	7086 V	I_1	7.250 A	P_1	41461 W
V_2	7085 V	7070 V /	7054 V	I_2	5.450 A	P_2	27780 W
V_3	7085 V	7082 V /	7060 V	I_3	7.070 A	P_3	35209 W
V_{AVG}	7085 V	7085 V /	7067 V	I_{AVG}	6.590 A	Pm	104450 W
					0.035 %	Pc	104723 W

105 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	7440 V	7459 V /	7439 V	I_1	7.690 A	P_1	46831 W
V_2	7440 V	7424 V /	7405 V	I_2	5.630 A	P_2	31194 W
V_3	7440 V	7437 V /	7413 V	I_3	7.230 A	P_3	38987 W
V_{AVG}	7440 V	7440 V /	7419 V	I_{AVG}	6.850 A	Pm	117012 W
					0.036 %	Pc	117347 W

110 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	7794 V	7814 V /	7790 V	I_1	8.220 A	P_1	52853 W
V_2	7794 V	7775 V /	7753 V	I_2	5.900 A	P_2	34962 W
V_3	7794 V	7791 V /	7762 V	I_3	7.390 A	P_3	43325 W
V_{AVG}	7794 V	7794 V /	7768 V	I_{AVG}	7.170 A	Pm	131140 W
					0.038 %	Pc	131567 W

Date of Test : 2013. 02. 22 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of No load losses and exciting current

Serial No.
20120871TKE001

※ Before Impulse test

Test frequency **60 Hz,** **19.8 ℃**

TV side connection at rated voltage **14.111 kV,** **based** **403 MVA** HV / LV Tap No. : 5 / 16L

Supply voltage/√3 (V) (Phase to Ground)			Current(A)					No load losses (W)		
			Phase			Average				
(%)	mean	rms	Ia	Ib	Ic	Io	%	P_m	$P_C(T_m)$	$P_C(T_r)$
100	8148	8123	8.870	6.550	7.080	7.500	0.045	146283	146747	146728

Remark :

- **$P_C(T_r)$ is Calculated as per IEEE std C57. 12. 90-2006 Clause 8.4**
- P_m is measured no-load losses at temperature T_m
- $Pc(T_m)$ is the no-load losses, corrected for waveform, at temperature T_m
- $Pc(T_r)$ is the no-load losses, corrected to the reference temperature T_r = 20℃

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of No load losses and exciting current

Serial No. 20120871TKE001

403 MVA BASE

Test frequency at 60 Hz ※ Before Impulse test HV / LV Tap No. : 5 / 16L

TV Side Connection at rated voltage : 14.111 kV, Oil temp. : 19.8 ℃

100 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
	Rated value (mean)	Tested value (mean / rms)					
V_1	8147 V	8176 V /	8145 V	I_1	8.870 A	P_1	59553 W
V_2	8147 V	8121 V /	8105 V	I_2	6.550 A	P_2	39633 W
V_3	8147 V	8148 V /	8117 V	I_3	7.080 A	P_3	47097 W
V_{AVG}	8147 V	8148 V /	8123 V	I_{AVG}	7.500 A	Pm	146283 W
					0.045 %	Pc	146747 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of No load losses and exciting current

Serial No.
20120871TKE001

※ After Impulse test

Test frequency **60 Hz,** **20.8 ℃**

TV side connection at rated voltage **12.272 kV,** **based** **403 MVA** HV / LV Tap No. : 3 / 16R

Supply voltage/√3 (V) (Phase to Ground)			Current(A)					No load losses (W)		
			Phase			Average				
(%)	mean	rms	Ia	Ib	Ic	Io	%	P_m	$P_C(T_m)$	$P_C(T_r)$
90	6377	6362	6.550	5.180	6.740	6.150	0.032	83626	83826	83870
100	7085	7066	7.320	5.500	7.180	6.670	0.035	105204	105481	105536
105	7441	7419	7.760	5.680	7.350	6.930	0.037	117926	118265	118326
110	7795	7769	8.290	5.940	7.520	7.250	0.038	132137	132578	132647

Remark :

- **$P_C(T_r)$ is Calculated as per IEEE std C57. 12. 90-2006 Clause 8.4**
- P_m is measured no-load losses at temperature T_m
- $Pc(T_m)$ is the no-load losses, corrected for waveform, at temperature T_m
- $Pc(T_r)$ is the no-load losses, corrected to the reference temperature T_r = 20℃

Date of Test : 2013. 02. 25	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of No load losses and exciting current

Serial No. 20120871TKE001

403 MVA BASE

Test frequency at 60 Hz ※ After Impulse test HV / LV Tap No. : 3 / 16R

TV Side Connection at rated voltage : 12.272 kV, Oil temp. : 20.8 ℃

90 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	6377 V	6394 V /	6379 V	I_1	6.550 A	P_1	32549 W
V_2	6377 V	6366 V /	6351 V	I_2	5.180 A	P_2	22106 W
V_3	6377 V	6371 V /	6356 V	I_3	6.740 A	P_3	28971 W
V_{AVG}	6377 V	6377 V /	6362 V	I_{AVG}	6.150 A	Pm	83626 W
					0.032 %	Pc	83826 W

100 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	7085 V	7104 V /	7085 V	I_1	7.320 A	P_1	41632 W
V_2	7085 V	7070 V /	7053 V	I_2	5.500 A	P_2	28017 W
V_3	7085 V	7081 V /	7060 V	I_3	7.180 A	P_3	35555 W
V_{AVG}	7085 V	7085 V /	7066 V	I_{AVG}	6.670 A	Pm	105204 W
					0.035 %	Pc	105481 W

105 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	7440 V	7460 V /	7440 V	I_1	7.760 A	P_1	47048 W
V_2	7440 V	7425 V /	7405 V	I_2	5.680 A	P_2	31461 W
V_3	7440 V	7437 V /	7413 V	I_3	7.350 A	P_3	39416 W
V_{AVG}	7440 V	7441 V /	7419 V	I_{AVG}	6.930 A	Pm	117926 W
					0.037 %	Pc	118265 W

110 % of Rated Voltage

Phase to Ground Voltage				Exciting current		Losses	
Rated value (mean)		Tested value (mean / rms)					
V_1	7794 V	7816 V /	7791 V	I_1	8.290 A	P_1	53078 W
V_2	7794 V	7777 V /	7754 V	I_2	5.940 A	P_2	35224 W
V_3	7794 V	7792 V /	7763 V	I_3	7.520 A	P_3	43835 W
V_{AVG}	7794 V	7795 V /	7769 V	I_{AVG}	7.250 A	Pm	132137 W
					0.038 %	Pc	132578 W

Date of Test : 2013. 02. 25 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

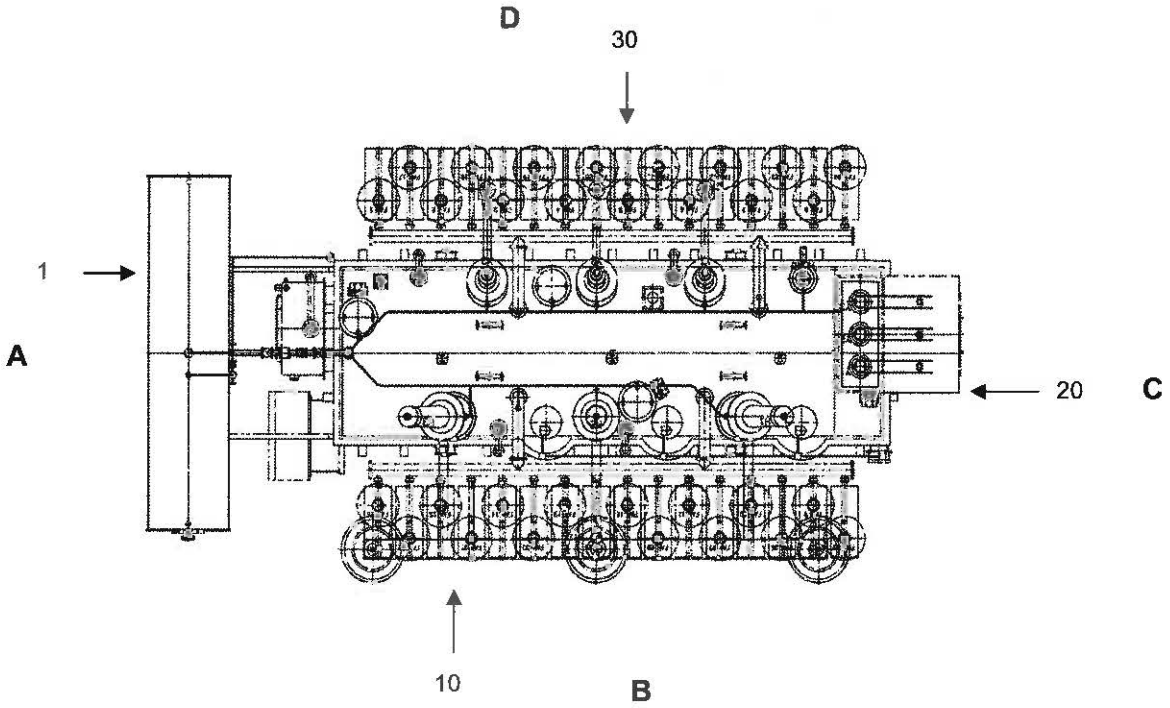
Measurement of sound level

Serial No.
20120871TKE001

At rated voltage 345/138/13.2kV, frequency 60Hz, and type of cooling ONAN Tap : 5/16L
in accordance with IEEE C57.12.90

1. Guaranteed value : 77.0 dB
2. Measured value : 72.3 dB without cooling system (1 Feet)
3. Ambient sound level : 60.0 dB (A : 60 B : 61 C : 61 D : 60)
4. Measured value(Unit : dB) (E : 59 F : 60 G : 60 H : 59)

	1/3 H	2/3 H		1/3 H	2/3 H		1/3 H	2/3 H
1	74.0	73.5	16	74.7	70.2	31	73.7	71.3
2	75.0	70.1	17	74.8	70.5	32	68.7	70.3
3	75.5	70.4	18	73.3	75.5	33	72.9	71.2
4	72.6	72.0	19	71.4	73.9	34	73.2	70.4
5	72.8	70.1	20	72.2	70.5	35	68.4	65.0
6	69.6	69.4	21	74.4	73.2	36	70.0	70.5
7	74.0	74.7	22	76.1	72.3	37	-	-
8	70.0	74.2	23	68.4	73.3	38	-	-
9	72.5	73.2	24	72.6	68.7	39	-	-
10	74.1	74.7	25	68.7	69.4	40	-	-
11	69.8	75.1	26	73.5	74.0	41	-	-
12	70.0	75.2	27	75.8	74.1	42	-	-
13	76.8	71.3	28	72.5	71.4	43	-	-
14	75.6	73.6	29	72.7	72.7	44	-	-
15	70.1	71.2	30	71.8	73.0	45	-	-



Date of Test : 2013. 02. 22 | Tested by : B. Y. Cheon

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

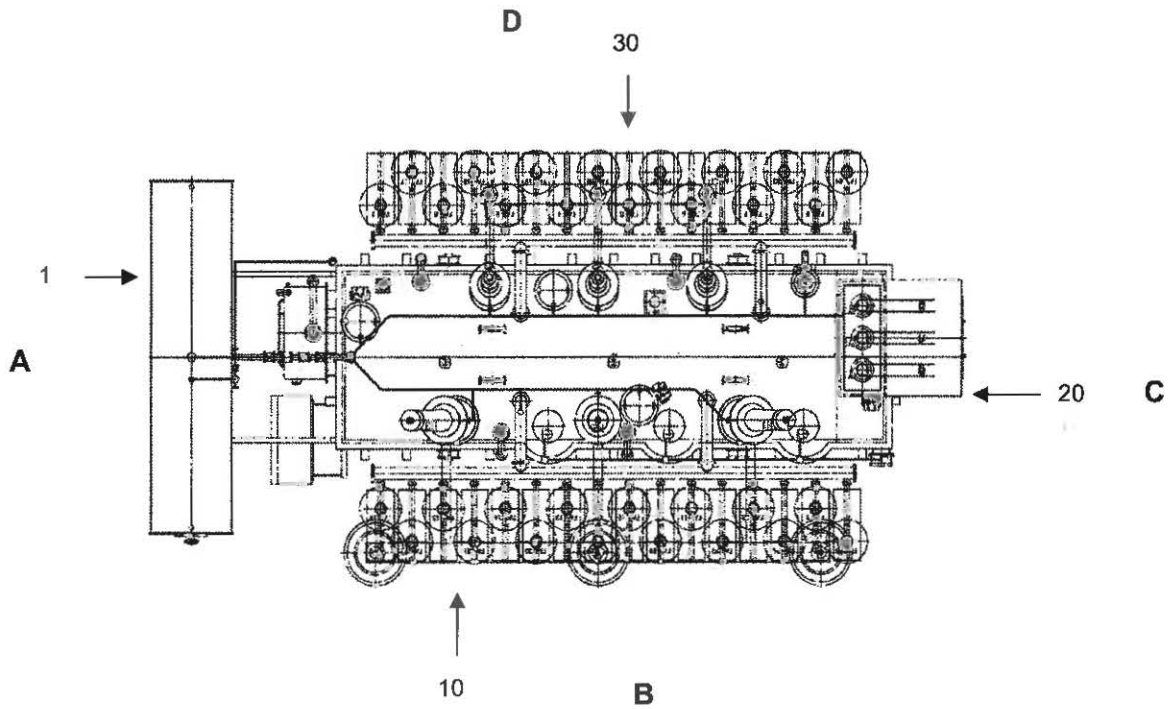
Measurement of sound level

Serial No.
20120871TKE001

At rated voltage 345/138/13.2kV, frequency 60Hz, and type of cooling ONAF2 Tap : 5/16L.
in accordance with IEEE C57.12.90

1. Guaranteed value : 80.0 dB
2. Measured value : 76.0 dB with cooling system (6 Feet)
3. Ambient sound level : 60.1 dB (A : 60 B : 61 C : 61 D : 60)
4. Measured value(Unit : dB) (E : 59 F : 60 G : 60 H : 59)

	1/3 H	2/3 H		1/3 H	2/3 H		1/3 H	2/3 H
1	76.1	75.4	16	78.6	78.2	31	78.8	75.3
2	75.2	73.1	17	77.2	76.7	32	78.4	77.2
3	74.0	72.8	18	76.5	75.3	33	77.4	76.4
4	74.2	73.1	19	77.2	74.2	34	75.1	76.8
5	72.6	71.4	20	76.1	75.0	35	74.3	75.2
6	74.3	74.2	21	78.2	74.9	36	74.2	75.1
7	76.3	74.5	22	76.3	75.2	37	-	-
8	74.5	77.0	23	76.0	75.1	38	-	-
9	76.3	76.1	24	74.4	75.2	39	-	-
10	78.3	77.8	25	75.5	74.2	40	-	-
11	77.1	76.5	26	76.8	74.5	41	-	-
12	77.4	79.1	27	79.2	76.8	42	-	-
13	76.1	77.2	28	78.1	76.0	43	-	-
14	77.2	78.5	29	78.2	76.5	44	-	-
15	76.2	77.2	30	78.3	75.4	45	-	-



Date of Test : 2013. 02. 22 | Tested by : B. Y. Cheon

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No. 20120871TKE001

Measurement on 403 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (LV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/1L	362250	642.3	642.7	30604	8.448	399871	437595
2/1L	353625	658.0	658.7	28962	8.190	396805	434024
3/1L	345000	674.4	674.6	27434	7.952	399255	434751
4/1L	336375	691.7	692.4	26299	7.819	404500	437612
5/1L	327750	709.9	710.4	24874	7.589	407927	438908

Correction on 535 MVA base

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/1L	362250	852.7	-	40628	11.216	-	771206
2/1L	353625	873.5	-	38448	10.873	-	764912
3/1L	345000	895.3	-	36420	10.557	-	766192
4/1L	336375	918.3	-	34914	10.380	-	771235
5/1L	327750	942.4	-	33021	10.075	-	773518

Date of Test : 2013. 02. 22 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

403 MVA BASE

LV Tap No : 1L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	642.3 A	642.7 A	V_1	17720 V	P_1	128475 W
I_2	642.3 A	642.9 A	V_2	17643 V	P_2	124468 W
I_3	642.3 A	642.5 A	V_3	17643 V	P_3	146928 W
I_{avg}	642.3 A	642.7 A	V_{avg}	17669 V	P_t	399871 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	658.0 A	658.7 A	V_1	16772 V	P_1	127374 W
I_2	658.0 A	658.9 A	V_2	16696 V	P_2	124943 W
I_3	658.0 A	658.5 A	V_3	16694 V	P_3	144488 W
I_{avg}	658.0 A	658.7 A	V_{avg}	16721 V	P_t	396805 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	674.4 A	674.7 A	V_1	15889 V	P_1	128439 W
I_2	674.4 A	674.9 A	V_2	15816 V	P_2	127115 W
I_3	674.4 A	674.3 A	V_3	15812 V	P_3	143701 W
I_{avg}	674.4 A	674.6 A	V_{avg}	15839 V	P_t	399255 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	691.7 A	692.1 A	V_1	15218 V	P_1	127021 W
I_2	691.7 A	692.6 A	V_2	15126 V	P_2	129905 W
I_3	691.7 A	692.3 A	V_3	15207 V	P_3	147574 W
I_{avg}	691.7 A	692.4 A	V_{avg}	15184 V	P_t	404500 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

403 MVA BASE

LV Tap No : 1L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	709.9 A	710.3 A	V_1	14406 V	P_1	126665 W
I_2	709.9 A	710.7 A	V_2	14342 V	P_2	131985 W
I_3	709.9 A	710.3 A	V_3	14335 V	P_3	149277 W
I_{avg}	709.9 A	710.4 A	V_{avg}	14361 V	P_t	407927 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/1L	
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	362250	/ 138070	
Rated current (A)	HV / LV	:	642.3	/ 1685.2	
Impedance voltage (V)		:	30604		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	399871		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1249022	0.1247599	0.1247610
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	259145.0 (W)	at 85 ℃	325587.2 (W)
Stray loss	:	at 20 ℃	140726.0 (W)	at 85 ℃	112008.2 (W)
Load loss	:	at 85 ℃	437595.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.109 (%)		
% Reactance voltage drop	:	at 85 ℃	8.448 (%)		
% Impedance voltage drop	:	at 85 ℃	8.448 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.844 (%)	Load factor	0.60	:	99.892 (%)
Load factor	1.10	:	99.857 (%)	Load factor	0.50	:	99.894 (%)
Load factor	1.00	:	99.866 (%)	Load factor	0.40	:	99.892 (%)
Load factor	0.90	:	99.874 (%)	Load factor	0.30	:	99.881 (%)
Load factor	0.80	:	99.881 (%)	Load factor	0.25	:	99.869 (%)
Load factor	0.75	:	99.884 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.465 (%)	Power factor	0.70	:	6.279 (%)
Power factor	0.95	:	3.060 (%)	Power factor	0.65	:	6.636 (%)
Power factor	0.90	:	4.065 (%)	Power factor	0.60	:	6.947 (%)
Power factor	0.85	:	4.796 (%)	Power factor	0.55	:	7.219 (%)
Power factor	0.80	:	5.379 (%)	Power factor	0.50	:	7.455 (%)
Power factor	0.75	:	5.865 (%)	Power factor	0.25	:	8.227 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/1L		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	353625	/ 138121	
Rated current (A)	HV / LV	:	658.0	/ 1684.6	
Impedance voltage (V)		:	28962		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	396805		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1196655	0.1195434	0.1195302
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	256689.5 (W)	at 85 ℃	322502.1 (W)
Stray loss	:	at 20 ℃	140115.5 (W)	at 85 ℃	111522.3 (W)
Load loss	:	at 85 ℃	434024.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.108 (%)		
% Reactance voltage drop	:	at 85 ℃	8.189 (%)		
% Impedance voltage drop	:	at 85 ℃	8.190 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.845 (%)	Load factor	0.60	:	99.892 (%)
Load factor	1.10	:	99.858 (%)	Load factor	0.50	:	99.894 (%)
Load factor	1.00	:	99.866 (%)	Load factor	0.40	:	99.892 (%)
Load factor	0.90	:	99.874 (%)	Load factor	0.30	:	99.881 (%)
Load factor	0.80	:	99.882 (%)	Load factor	0.25	:	99.869 (%)
Load factor	0.75	:	99.885 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.443 (%)	Power factor	0.70	:	6.084 (%)
Power factor	0.95	:	2.959 (%)	Power factor	0.65	:	6.431 (%)
Power factor	0.90	:	3.935 (%)	Power factor	0.60	:	6.733 (%)
Power factor	0.85	:	4.644 (%)	Power factor	0.55	:	6.996 (%)
Power factor	0.80	:	5.210 (%)	Power factor	0.50	:	7.226 (%)
Power factor	0.75	:	5.682 (%)	Power factor	0.25	:	7.975 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/1		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	345000	/ 138175	
Rated current (A)	HV / LV	:	674.4	/ 1683.9	
Impedance voltage (V)		:	27434		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	399255		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1144483	0.1143317	0.1143075
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	254031.6 (W)	at 85 ℃	319162.7 (W)
Stray loss	:	at 20 ℃	145223.4 (W)	at 85 ℃	115587.9 (W)
Load loss	:	at 85 ℃	434750.6 (W)		
% Resistance voltage drop	:	at 85 ℃	0.108 (%)		
% Reactance voltage drop	:	at 85 ℃	7.951 (%)		
% Impedance voltage drop	:	at 85 ℃	7.952 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.845 (%)	Load factor	0.60	:	99.892 (%)
Load factor	1.10	:	99.858 (%)	Load factor	0.50	:	99.894 (%)
Load factor	1.00	:	99.866 (%)	Load factor	0.40	:	99.892 (%)
Load factor	0.90	:	99.874 (%)	Load factor	0.30	:	99.881 (%)
Load factor	0.80	:	99.881 (%)	Load factor	0.25	:	99.869 (%)
Load factor	0.75	:	99.885 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.424 (%)	Power factor	0.70	:	5.904 (%)
Power factor	0.95	:	2.868 (%)	Power factor	0.65	:	6.242 (%)
Power factor	0.90	:	3.816 (%)	Power factor	0.60	:	6.535 (%)
Power factor	0.85	:	4.505 (%)	Power factor	0.55	:	6.792 (%)
Power factor	0.80	:	5.055 (%)	Power factor	0.50	:	7.015 (%)
Power factor	0.75	:	5.514 (%)	Power factor	0.25	:	7.743 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 4/1L		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	336375	/ 138232	
Rated current (A)	HV / LV	:	691.7	/ 1683.2	
Impedance voltage (V)		:	26299		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	404500		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1092648	0.1091520	0.1091134
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	251179.5 (W)	at 85 ℃	315579.4 (W)
Stray loss	:	at 20 ℃	153320.5 (W)	at 85 ℃	122032.6 (W)
Load loss	:	at 85 ℃	437612.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.109 (%)		
% Reactance voltage drop	:	at 85 ℃	7.818 (%)		
% Impedance voltage drop	:	at 85 ℃	7.819 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.844 (%)	Load factor	0.60	:	99.892 (%)
Load factor	1.10	:	99.857 (%)	Load factor	0.50	:	99.894 (%)
Load factor	1.00	:	99.866 (%)	Load factor	0.40	:	99.892 (%)
Load factor	0.90	:	99.874 (%)	Load factor	0.30	:	99.881 (%)
Load factor	0.80	:	99.881 (%)	Load factor	0.25	:	99.869 (%)
Load factor	0.75	:	99.884 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.414 (%)	Power factor	0.70	:	5.805 (%)
Power factor	0.95	:	2.818 (%)	Power factor	0.65	:	6.137 (%)
Power factor	0.90	:	3.750 (%)	Power factor	0.60	:	6.425 (%)
Power factor	0.85	:	4.428 (%)	Power factor	0.55	:	6.677 (%)
Power factor	0.80	:	4.969 (%)	Power factor	0.50	:	6.898 (%)
Power factor	0.75	:	5.420 (%)	Power factor	0.25	:	7.614 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 5/1L.		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	327750	/ 138292	
Rated current (A)	HV / LV	:	709.9	/ 1682.5	
Impedance voltage (V)		:	24874		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	407927		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1040834	0.1039766	0.1039184
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	248069.5 (W)	at 85 ℃	311672.0 (W)
Stray loss	:	at 20 ℃	159857.5 (W)	at 85 ℃	127235.6 (W)
Load loss	:	at 85 ℃	438907.6 (W)		
% Resistance voltage drop	:	at 85 ℃	0.109 (%)		
% Reactance voltage drop	:	at 85 ℃	7.589 (%)		
% Impedance voltage drop	:	at 85 ℃	7.589 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.843 (%)	Load factor	0.60	:	99.891 (%)
Load factor	1.10	:	99.857 (%)	Load factor	0.50	:	99.894 (%)
Load factor	1.00	:	99.865 (%)	Load factor	0.40	:	99.892 (%)
Load factor	0.90	:	99.873 (%)	Load factor	0.30	:	99.881 (%)
Load factor	0.80	:	99.881 (%)	Load factor	0.25	:	99.869 (%)
Load factor	0.75	:	99.884 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.397 (%)	Power factor	0.70	:	5.633 (%)
Power factor	0.95	:	2.730 (%)	Power factor	0.65	:	5.955 (%)
Power factor	0.90	:	3.636 (%)	Power factor	0.60	:	6.236 (%)
Power factor	0.85	:	4.294 (%)	Power factor	0.55	:	6.481 (%)
Power factor	0.80	:	4.821 (%)	Power factor	0.50	:	6.695 (%)
Power factor	0.75	:	5.259 (%)	Power factor	0.25	:	7.391 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No.
20120871TKE001

Measurement on 672 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (LV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/1L	362250	1071.0	1071.2	50940	14.062	1121665	1224557
2/1L	353625	1097.1	1097.9	48213	13.634	1114711	1215879
3/1L	345000	1124.6	1124.7	45674	13.239	1116690	1214051
4/1L	336375	1153.4	1153.8	43518	12.937	1136662	1226295
5/1L	327750	1183.8	1183.9	41396	12.631	1143038	1227388

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

672 MVA BASE

LV Tap No.: 1L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1071.0 A	1071.0 A	V_1	29496 V	P_1	360861 W
I_2	1071.0 A	1071.5 A	V_2	29366 V	P_2	349349 W
I_3	1071.0 A	1070.9 A	V_3	29368 V	P_3	411455 W
I_{avg}	1071.0 A	1071.2 A	V_{avg}	29410 V	P_t	1121665 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1097.1 A	1097.9 A	V_1	27922 V	P_1	358480 W
I_2	1097.1 A	1098.4 A	V_2	27795 V	P_2	351286 W
I_3	1097.1 A	1097.5 A	V_3	27791 V	P_3	404945 W
I_{avg}	1097.1 A	1097.9 A	V_{avg}	27836 V	P_t	1114711 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1124.6 A	1124.3 A	V_1	26450 V	P_1	359824 W
I_2	1124.6 A	1125.2 A	V_2	26329 V	P_2	353128 W
I_3	1124.6 A	1124.5 A	V_3	26332 V	P_3	403738 W
I_{avg}	1124.6 A	1124.7 A	V_{avg}	26370 V	P_t	1116690 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1153.4 A	1153.5 A	V_1	25202 V	P_1	356861 W
I_2	1153.4 A	1154.3 A	V_2	25089 V	P_2	365308 W
I_3	1153.4 A	1153.7 A	V_3	25084 V	P_3	414493 W
I_{avg}	1153.4 A	1153.8 A	V_{avg}	25125 V	P_t	1136662 W

Date of Test : 2013. 02. 22 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

672 MVA BASE

LV Tap No : 1L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1183.8 A	1183.5 A	V_1	23975 V	P_1	355782 W
I_2	1183.8 A	1184.4 A	V_2	23867 V	P_2	369522 W
I_3	1183.8 A	1183.6 A	V_3	23859 V	P_3	417734 W
I_{avg}	1183.8 A	1183.9 A	V_{avg}	23900 V	P_t	1143038 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/1L
Capacity (kVA)		:	672000	
Rated voltage (V)	HV / LV	:	362250	/ 138070
Rated current (A)	HV / LV	:	1071.0	/ 2810.0
Impedance voltage (V)		:	50940	
No-load losses (W)		:	104709	
Load losses (W)	19.8 ℃	:	1121665	
Winding resistance	22.0 ℃			

HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1249022	0.1247599	0.1247610
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	720561.9 (W)	at 85 ℃	905306.8 (W)
Stray loss	:	at 20 ℃	401103.1 (W)	at 85 ℃	319250.5 (W)
Load loss	:	at 85 ℃	1224557.3 (W)		
% Resistance voltage drop	:	at 85 ℃	0.182 (%)		
% Reactance voltage drop	:	at 85 ℃	14.061 (%)		
% Impedance voltage drop	:	at 85 ℃	14.062 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.760 (%)	Load factor	0.60	:	99.865 (%)
Load factor	1.10	:	99.786 (%)	Load factor	0.50	:	99.878 (%)
Load factor	1.00	:	99.803 (%)	Load factor	0.40	:	99.888 (%)
Load factor	0.90	:	99.819 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.835 (%)	Load factor	0.25	:	99.892 (%)
Load factor	0.75	:	99.843 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.171 (%)	Power factor	0.70	:	10.641 (%)
Power factor	0.95	:	5.448 (%)	Power factor	0.65	:	11.209 (%)
Power factor	0.90	:	7.084 (%)	Power factor	0.60	:	11.702 (%)
Power factor	0.85	:	8.265 (%)	Power factor	0.55	:	12.131 (%)
Power factor	0.80	:	9.203 (%)	Power factor	0.50	:	12.504 (%)
Power factor	0.75	:	9.981 (%)	Power factor	0.25	:	13.716 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/1L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	353625	/ 138121	
Rated current (A)	HV / LV	:	1097.1	/ 2809.0	
Impedance voltage (V)		:	48213		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1114711		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1196655	0.1195434	0.1195302
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	713734.2 (W)	at 85 ℃	896728.6 (W)
Stray loss	:	at 20 ℃	400976.8 (W)	at 85 ℃	319149.9 (W)
Load loss	:	at 85 ℃	1215878.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.181 (%)		
% Reactance voltage drop	:	at 85 ℃	13.633 (%)		
% Impedance voltage drop	:	at 85 ℃	13.634 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.762 (%)	Load factor	0.60	:	99.866 (%)
Load factor	1.10	:	99.787 (%)	Load factor	0.50	:	99.879 (%)
Load factor	1.00	:	99.804 (%)	Load factor	0.40	:	99.889 (%)
Load factor	0.90	:	99.820 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.836 (%)	Load factor	0.25	:	99.893 (%)
Load factor	0.75	:	99.844 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.110 (%)	Power factor	0.70	:	10.306 (%)
Power factor	0.95	:	5.260 (%)	Power factor	0.65	:	10.858 (%)
Power factor	0.90	:	6.848 (%)	Power factor	0.60	:	11.338 (%)
Power factor	0.85	:	7.996 (%)	Power factor	0.55	:	11.755 (%)
Power factor	0.80	:	8.908 (%)	Power factor	0.50	:	12.119 (%)
Power factor	0.75	:	9.664 (%)	Power factor	0.25	:	13.298 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/1L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	345000	/ 138175	
Rated current (A)	HV / LV	:	1124.6	/ 2807.9	
Impedance voltage (V)		:	45674		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1116690		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1144483	0.1143317	0.1143075
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	706343.8 (W)	at 85 ℃	887443.3 (W)
Stray loss	:	at 20 ℃	410346.2 (W)	at 85 ℃	326607.3 (W)
Load loss	:	at 85 ℃	1214050.7 (W)		
% Resistance voltage drop	:	at 85 ℃	0.181 (%)		
% Reactance voltage drop	:	at 85 ℃	13.238 (%)		
% Impedance voltage drop	:	at 85 ℃	13.239 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.762 (%)	Load factor	0.60	:	99.866 (%)
Load factor	1.10	:	99.788 (%)	Load factor	0.50	:	99.879 (%)
Load factor	1.00	:	99.804 (%)	Load factor	0.40	:	99.889 (%)
Load factor	0.90	:	99.820 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.836 (%)	Load factor	0.25	:	99.893 (%)
Load factor	0.75	:	99.844 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.057 (%)	Power factor	0.70	:	9.998 (%)
Power factor	0.95	:	5.089 (%)	Power factor	0.65	:	10.536 (%)
Power factor	0.90	:	6.633 (%)	Power factor	0.60	:	11.003 (%)
Power factor	0.85	:	7.749 (%)	Power factor	0.55	:	11.409 (%)
Power factor	0.80	:	8.637 (%)	Power factor	0.50	:	11.763 (%)
Power factor	0.75	:	9.373 (%)	Power factor	0.25	:	12.912 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 4/1L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	336375	/ 138232	
Rated current (A)	HV / LV	:	1153.4	/ 2806.7	
Impedance voltage (V)		:	43518		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1136662		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1092648	0.1091520	0.1091134
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	698413.5 (W)	at 85 ℃	877479.8 (W)
Stray loss	:	at 20 ℃	438248.5 (W)	at 85 ℃	348815.6 (W)
Load loss	:	at 85 ℃	1226295.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.182 (%)		
% Reactance voltage drop	:	at 85 ℃	12.936 (%)		
% Impedance voltage drop	:	at 85 ℃	12.937 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.760 (%)	Load factor	0.60	:	99.865 (%)
Load factor	1.10	:	99.786 (%)	Load factor	0.50	:	99.878 (%)
Load factor	1.00	:	99.802 (%)	Load factor	0.40	:	99.888 (%)
Load factor	0.90	:	99.819 (%)	Load factor	0.30	:	99.893 (%)
Load factor	0.80	:	99.835 (%)	Load factor	0.25	:	99.892 (%)
Load factor	0.75	:	99.843 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.019 (%)	Power factor	0.70	:	9.764 (%)
Power factor	0.95	:	4.961 (%)	Power factor	0.65	:	10.291 (%)
Power factor	0.90	:	6.472 (%)	Power factor	0.60	:	10.748 (%)
Power factor	0.85	:	7.564 (%)	Power factor	0.55	:	11.147 (%)
Power factor	0.80	:	8.432 (%)	Power factor	0.50	:	11.493 (%)
Power factor	0.75	:	9.152 (%)	Power factor	0.25	:	12.618 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 5/1L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	327750	/ 138292	
Rated current (A)	HV / LV	:	1183.8	/ 2805.5	
Impedance voltage (V)		:	41396		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1143038		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1040834	0.1039766	0.1039184
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690

Output data

Copper loss	:	at 20 ℃	689766.0 (W)	at 85 ℃	866615.1 (W)
Stray loss	:	at 20 ℃	453272.0 (W)	at 85 ℃	360773.3 (W)
Load loss	:	at 85 ℃	1227388.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.183 (%)		
% Reactance voltage drop	:	at 85 ℃	12.629 (%)		
% Impedance voltage drop	:	at 85 ℃	12.631 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.760 (%)	Load factor	0.60	:	99.865 (%)
Load factor	1.10	:	99.785 (%)	Load factor	0.50	:	99.878 (%)
Load factor	1.00	:	99.802 (%)	Load factor	0.40	:	99.888 (%)
Load factor	0.90	:	99.819 (%)	Load factor	0.30	:	99.893 (%)
Load factor	0.80	:	99.835 (%)	Load factor	0.25	:	99.892 (%)
Load factor	0.75	:	99.842 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.980 (%)	Power factor	0.70	:	9.526 (%)
Power factor	0.95	:	4.830 (%)	Power factor	0.65	:	10.042 (%)
Power factor	0.90	:	6.306 (%)	Power factor	0.60	:	10.489 (%)
Power factor	0.85	:	7.374 (%)	Power factor	0.55	:	10.879 (%)
Power factor	0.80	:	8.223 (%)	Power factor	0.50	:	11.218 (%)
Power factor	0.75	:	8.928 (%)	Power factor	0.25	:	12.318 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No. 20120871TKE001

Measurement on 403 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (LV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/16R	362250	642.3	642.7	32393	8.942	405050	434009
2/16R	353625	658.0	658.2	30631	8.662	398703	428066
3/16R	345000	674.4	674.8	29046	8.419	398481	426911
4/16R	336375	691.7	692.2	27548	8.190	401388	428167
5/16R	327750	709.9	710.7	26149	7.978	403568	428733

Correction on 535 MVA base

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/16R	362250	852.7	-	43003	11.871	-	764886
2/16R	353625	873.5	-	40664	11.499	-	754410
3/16R	345000	895.3	-	38560	11.177	-	752376
4/16R	336375	918.3	-	36572	10.872	-	754589
5/16R	327750	942.4	-	34714	10.592	-	755587

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

403 MVA BASE

LV Tap No : 16R

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	642.3 A	642.9 A	V_1	18758 V	P_1	134736 W
I_2	642.3 A	643.2 A	V_2	18699 V	P_2	124373 W
I_3	642.3 A	641.9 A	V_3	18648 V	P_3	145941 W
I_{avg}	642.3 A	642.7 A	V_{avg}	18702 V	P_t	405050 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	658.0 A	658.6 A	V_1	17718 V	P_1	133791 W
I_2	658.0 A	658.7 A	V_2	17692 V	P_2	123395 W
I_3	658.0 A	657.5 A	V_3	17644 V	P_3	141517 W
I_{avg}	658.0 A	658.2 A	V_{avg}	17685 V	P_t	398703 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	674.4 A	675.1 A	V_1	16814 V	P_1	132233 W
I_2	674.4 A	674.9 A	V_2	16714 V	P_2	124910 W
I_3	674.4 A	674.5 A	V_3	16783 V	P_3	141338 W
I_{avg}	674.4 A	674.8 A	V_{avg}	16770 V	P_t	398481 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	691.7 A	692.5 A	V_1	15947 V	P_1	130417 W
I_2	691.7 A	692.4 A	V_2	15852 V	P_2	127714 W
I_3	691.7 A	691.9 A	V_3	15917 V	P_3	143257 W
I_{avg}	691.7 A	692.2 A	V_{avg}	15905 V	P_t	401388 W

Date of Test : 2013. 02. 22 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

403 MVA BASE

LV Tap No : 16R

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	709.9 A	710.5 A	V_1	15142 V	P_1	130017 W
I_2	709.9 A	711.1 A	V_2	15068 V	P_2	130335 W
I_3	709.9 A	710.5 A	V_3	15082 V	P_3	143216 W
I_{avg}	709.9 A	710.7 A	V_{avg}	15097 V	P_t	403568 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/16R	
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	362250	/ 152440	
Rated current (A)	HV / LV	:	642.3	/ 1526.3	
Impedance voltage (V)		:	32393		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	405050		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1249022	0.1247599	0.1247610
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	242404.9 (W)	at 85 ℃	304555.2 (W)
Stray loss	:	at 20 ℃	162645.1 (W)	at 85 ℃	129454.3 (W)
Load loss	:	at 85 ℃	434009.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.108 (%)		
% Reactance voltage drop	:	at 85 ℃	8.942 (%)		
% Impedance voltage drop	:	at 85 ℃	8.942 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.845 (%)	Load factor	0.60	:	99.892 (%)
Load factor	1.10	:	99.858 (%)	Load factor	0.50	:	99.894 (%)
Load factor	1.00	:	99.867 (%)	Load factor	0.40	:	99.892 (%)
Load factor	0.90	:	99.874 (%)	Load factor	0.30	:	99.881 (%)
Load factor	0.80	:	99.882 (%)	Load factor	0.25	:	99.869 (%)
Load factor	0.75	:	99.885 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.507 (%)	Power factor	0.70	:	6.652 (%)
Power factor	0.95	:	3.252 (%)	Power factor	0.65	:	7.029 (%)
Power factor	0.90	:	4.314 (%)	Power factor	0.60	:	7.357 (%)
Power factor	0.85	:	5.086 (%)	Power factor	0.55	:	7.643 (%)
Power factor	0.80	:	5.702 (%)	Power factor	0.50	:	7.893 (%)
Power factor	0.75	:	6.215 (%)	Power factor	0.25	:	8.707 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/16R		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	353625	/ 152255	
Rated current (A)	HV / LV	:	658.0	/ 1528.2	
Impedance voltage (V)		:	30631		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	398703		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1196655	0.1195434	0.1195302
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	240467.4 (W)	at 85 ℃	302120.9 (W)
Stray loss	:	at 20 ℃	158235.6 (W)	at 85 ℃	125944.6 (W)
Load loss	:	at 85 ℃	428065.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.106 (%)		
% Reactance voltage drop	:	at 85 ℃	8.662 (%)		
% Impedance voltage drop	:	at 85 ℃	8.662 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.847 (%)	Load factor	0.60	:	99.893 (%)
Load factor	1.10	:	99.860 (%)	Load factor	0.50	:	99.895 (%)
Load factor	1.00	:	99.868 (%)	Load factor	0.40	:	99.893 (%)
Load factor	0.90	:	99.876 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.883 (%)	Load factor	0.25	:	99.870 (%)
Load factor	0.75	:	99.886 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.481 (%)	Power factor	0.70	:	6.439 (%)
Power factor	0.95	:	3.141 (%)	Power factor	0.65	:	6.805 (%)
Power factor	0.90	:	4.171 (%)	Power factor	0.60	:	7.124 (%)
Power factor	0.85	:	4.920 (%)	Power factor	0.55	:	7.402 (%)
Power factor	0.80	:	5.518 (%)	Power factor	0.50	:	7.644 (%)
Power factor	0.75	:	6.015 (%)	Power factor	0.25	:	8.434 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/16R		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	345000	/ 152062	
Rated current (A)	HV / LV	:	674.4	/ 1530.1	
Impedance voltage (V)		:	29046		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	398481		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1144483	0.1143317	0.1143075
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	238344.1 (W)	at 85 ℃	299453.1 (W)
Stray loss	:	at 20 ℃	160136.9 (W)	at 85 ℃	127458.0 (W)
Load loss	:	at 85 ℃	426911.1 (W)		
% Resistance voltage drop	:	at 85 ℃	0.106 (%)		
% Reactance voltage drop	:	at 85 ℃	8.419 (%)		
% Impedance voltage drop	:	at 85 ℃	8.419 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.847 (%)	Load factor	0.60	:	99.893 (%)
Load factor	1.10	:	99.860 (%)	Load factor	0.50	:	99.895 (%)
Load factor	1.00	:	99.868 (%)	Load factor	0.40	:	99.893 (%)
Load factor	0.90	:	99.876 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.883 (%)	Load factor	0.25	:	99.870 (%)
Load factor	0.75	:	99.886 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.460 (%)	Power factor	0.70	:	6.256 (%)
Power factor	0.95	:	3.047 (%)	Power factor	0.65	:	6.612 (%)
Power factor	0.90	:	4.049 (%)	Power factor	0.60	:	6.922 (%)
Power factor	0.85	:	4.777 (%)	Power factor	0.55	:	7.192 (%)
Power factor	0.80	:	5.358 (%)	Power factor	0.50	:	7.429 (%)
Power factor	0.75	:	5.843 (%)	Power factor	0.25	:	8.198 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 4/16R		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	336375	/ 151859	
Rated current (A)	HV / LV	:	691.7	/ 1532.2	
Impedance voltage (V)		:	27548		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	401388		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1092648	0.1091520	0.1091134
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	236046.0 (W)	at 85 ℃	296565.9 (W)
Stray loss	:	at 20 ℃	165342.0 (W)	at 85 ℃	131600.8 (W)
Load loss	:	at 85 ℃	428166.7 (W)		
% Resistance voltage drop	:	at 85 ℃	0.106 (%)		
% Reactance voltage drop	:	at 85 ℃	8.189 (%)		
% Impedance voltage drop	:	at 85 ℃	8.190 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.847 (%)	Load factor	0.60	:	99.893 (%)
Load factor	1.10	:	99.860 (%)	Load factor	0.50	:	99.895 (%)
Load factor	1.00	:	99.868 (%)	Load factor	0.40	:	99.893 (%)
Load factor	0.90	:	99.876 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.883 (%)	Load factor	0.25	:	99.870 (%)
Load factor	0.75	:	99.886 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.442 (%)	Power factor	0.70	:	6.083 (%)
Power factor	0.95	:	2.958 (%)	Power factor	0.65	:	6.430 (%)
Power factor	0.90	:	3.933 (%)	Power factor	0.60	:	6.732 (%)
Power factor	0.85	:	4.643 (%)	Power factor	0.55	:	6.995 (%)
Power factor	0.80	:	5.209 (%)	Power factor	0.50	:	7.225 (%)
Power factor	0.75	:	5.681 (%)	Power factor	0.25	:	7.975 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 5/16R		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	327750	/ 151646	
Rated current (A)	HV / LV	:	709.9	/ 1534.3	
Impedance voltage (V)		:	26149		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	403568		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1040834	0.1039766	0.1039184
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	233508.1 (W)	at 85 ℃	293377.2 (W)
Stray loss	:	at 20 ℃	170059.9 (W)	at 85 ℃	135356.0 (W)
Load loss	:	at 85 ℃	428733.2 (W)		
% Resistance voltage drop	:	at 85 ℃	0.106 (%)		
% Reactance voltage drop	:	at 85 ℃	7.978 (%)		
% Impedance voltage drop	:	at 85 ℃	7.978 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.846 (%)	Load factor	0.60	:	99.893 (%)
Load factor	1.10	:	99.860 (%)	Load factor	0.50	:	99.895 (%)
Load factor	1.00	:	99.868 (%)	Load factor	0.40	:	99.893 (%)
Load factor	0.90	:	99.876 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.883 (%)	Load factor	0.25	:	99.870 (%)
Load factor	0.75	:	99.886 (%)	Load factor	0.20	:	99.849 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.425 (%)	Power factor	0.70	:	5.923 (%)
Power factor	0.95	:	2.877 (%)	Power factor	0.65	:	6.262 (%)
Power factor	0.90	:	3.828 (%)	Power factor	0.60	:	6.556 (%)
Power factor	0.85	:	4.519 (%)	Power factor	0.55	:	6.814 (%)
Power factor	0.80	:	5.071 (%)	Power factor	0.50	:	7.038 (%)
Power factor	0.75	:	5.531 (%)	Power factor	0.25	:	7.769 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No.
20120871TKE001

Measurement on 672 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (LV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/16R	362250	1071.0	1071.0	53879	14.874	1141183	1218660
2/16R	353625	1097.1	1097.3	50907	14.396	1125571	1203753
3/16R	345000	1124.6	1125.7	48246	13.985	1129081	1203828
4/16R	336375	1153.4	1154.5	45825	13.623	1131373	1202710
5/16R	327750	1183.8	1184.4	43514	13.277	1134211	1201719

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

672 MVA BASE

LV Tap No : 16R

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1071.0 A	1071.4 A	V_1	31214 V	P_1	379715 W
I_2	1071.0 A	1071.9 A	V_2	31071 V	P_2	351038 W
I_3	1071.0 A	1069.8 A	V_3	31037 V	P_3	410430 W
I_{avg}	1071.0 A	1071.0 A	V_{avg}	31107 V	P_t	1141183 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1097.1 A	1097.8 A	V_1	29498 V	P_1	377241 W
I_2	1097.1 A	1098.1 A	V_2	29355 V	P_2	350010 W
I_3	1097.1 A	1096.0 A	V_3	29321 V	P_3	398320 W
I_{avg}	1097.1 A	1097.3 A	V_{avg}	29391 V	P_t	1125571 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1124.6 A	1126.1 A	V_1	27961 V	P_1	374312 W
I_2	1124.6 A	1125.9 A	V_2	27793 V	P_2	354293 W
I_3	1124.6 A	1125.2 A	V_3	27812 V	P_3	400476 W
I_{avg}	1124.6 A	1125.7 A	V_{avg}	27855 V	P_t	1129081 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1153.4 A	1154.8 A	V_1	26561 V	P_1	368153 W
I_2	1153.4 A	1154.8 A	V_2	26401 V	P_2	360869 W
I_3	1153.4 A	1153.9 A	V_3	26408 V	P_3	402351 W
I_{avg}	1153.4 A	1154.5 A	V_{avg}	26457 V	P_t	1131373 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

672 MVA BASE

LV Tap No : 16R

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1183.8 A	1184.0 A	V_1	25204 V	P_1	365408 W
I_2	1183.8 A	1185.1 A	V_2	25080 V	P_2	366751 W
I_3	1183.8 A	1184.2 A	V_3	25085 V	P_3	402052 W
I_{avg}	1183.8 A	1184.4 A	V_{avg}	25123 V	P_t	1134211 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 1/16R		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	362250	/ 152440	
Rated current (A)	HV / LV	:	1071.0	/ 2545.1	
Impedance voltage (V)		:	53879		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1141183		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1249022	0.1247599	0.1247610
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	674015.6 (W)	at 85 ℃	846826.5 (W)
Stray loss	:	at 20 ℃	467167.4 (W)	at 85 ℃	371833.1 (W)
Load loss	:	at 85 ℃	1218659.6 (W)		
% Resistance voltage drop	:	at 85 ℃	0.181 (%)		
% Reactance voltage drop	:	at 85 ℃	14.872 (%)		
% Impedance voltage drop	:	at 85 ℃	14.874 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.761 (%)	Load factor	0.60	:	99.865 (%)
Load factor	1.10	:	99.787 (%)	Load factor	0.50	:	99.878 (%)
Load factor	1.00	:	99.803 (%)	Load factor	0.40	:	99.889 (%)
Load factor	0.90	:	99.820 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.836 (%)	Load factor	0.25	:	99.892 (%)
Load factor	0.75	:	99.843 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.287 (%)	Power factor	0.70	:	11.277 (%)
Power factor	0.95	:	5.806 (%)	Power factor	0.65	:	11.874 (%)
Power factor	0.90	:	7.531 (%)	Power factor	0.60	:	12.392 (%)
Power factor	0.85	:	8.776 (%)	Power factor	0.55	:	12.843 (%)
Power factor	0.80	:	9.763 (%)	Power factor	0.50	:	13.236 (%)
Power factor	0.75	:	10.582 (%)	Power factor	0.25	:	14.508 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/16R		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	353625	/ 152255	
Rated current (A)	HV / LV	:	1097.1	/ 2548.2	
Impedance voltage (V)		:	50907		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1125571		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1196655	0.1195434	0.1195302
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	668628.2 (W)	at 85 ℃	840057.8 (W)
Stray loss	:	at 20 ℃	456942.8 (W)	at 85 ℃	363695.0 (W)
Load loss	:	at 85 ℃	1203752.8 (W)		
% Resistance voltage drop	:	at 85 ℃	0.179 (%)		
% Reactance voltage drop	:	at 85 ℃	14.395 (%)		
% Impedance voltage drop	:	at 85 ℃	14.396 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.764 (%)	Load factor	0.60	:	99.867 (%)
Load factor	1.10	:	99.789 (%)	Load factor	0.50	:	99.879 (%)
Load factor	1.00	:	99.806 (%)	Load factor	0.40	:	99.890 (%)
Load factor	0.90	:	99.822 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.837 (%)	Load factor	0.25	:	99.893 (%)
Load factor	0.75	:	99.845 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.215 (%)	Power factor	0.70	:	10.900 (%)
Power factor	0.95	:	5.592 (%)	Power factor	0.65	:	11.481 (%)
Power factor	0.90	:	7.265 (%)	Power factor	0.60	:	11.984 (%)
Power factor	0.85	:	8.472 (%)	Power factor	0.55	:	12.422 (%)
Power factor	0.80	:	9.431 (%)	Power factor	0.50	:	12.804 (%)
Power factor	0.75	:	10.226 (%)	Power factor	0.25	:	14.041 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/16R		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	345000	/ 152062	
Rated current (A)	HV / LV	:	1124.6	/ 2551.5	
Impedance voltage (V)		:	48246		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1129081		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1144483	0.1143317	0.1143075
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	662724.2 (W)	at 85 ℃	832640.1 (W)
Stray loss	:	at 20 ℃	466356.8 (W)	at 85 ℃	371187.9 (W)
Load loss	:	at 85 ℃	1203828.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.179 (%)		
% Reactance voltage drop	:	at 85 ℃	13.983 (%)		
% Impedance voltage drop	:	at 85 ℃	13.985 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.764 (%)	Load factor	0.60	:	99.867 (%)
Load factor	1.10	:	99.789 (%)	Load factor	0.50	:	99.879 (%)
Load factor	1.00	:	99.806 (%)	Load factor	0.40	:	99.890 (%)
Load factor	0.90	:	99.822 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.837 (%)	Load factor	0.25	:	99.893 (%)
Load factor	0.75	:	99.845 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.157 (%)	Power factor	0.70	:	10.578 (%)
Power factor	0.95	:	5.411 (%)	Power factor	0.65	:	11.144 (%)
Power factor	0.90	:	7.039 (%)	Power factor	0.60	:	11.634 (%)
Power factor	0.85	:	8.214 (%)	Power factor	0.55	:	12.061 (%)
Power factor	0.80	:	9.147 (%)	Power factor	0.50	:	12.433 (%)
Power factor	0.75	:	9.921 (%)	Power factor	0.25	:	13.639 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		/ 4/16R		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	336375	/ 151859	
Rated current (A)	HV / LV	:	1153.4	/ 2554.9	
Impedance voltage (V)		:	45825		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1131373		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1092648	0.1091520	0.1091134
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	656334.3 (W)	at 85 ℃	824612.0 (W)
Stray loss	:	at 20 ℃	475038.7 (W)	at 85 ℃	378098.1 (W)
Load loss	:	at 85 ℃	1202710.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.179 (%)		
% Reactance voltage drop	:	at 85 ℃	13.622 (%)		
% Impedance voltage drop	:	at 85 ℃	13.623 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.764 (%)	Load factor	0.60	:	99.867 (%)
Load factor	1.10	:	99.789 (%)	Load factor	0.50	:	99.879 (%)
Load factor	1.00	:	99.806 (%)	Load factor	0.40	:	99.890 (%)
Load factor	0.90	:	99.822 (%)	Load factor	0.30	:	99.894 (%)
Load factor	0.80	:	99.838 (%)	Load factor	0.25	:	99.893 (%)
Load factor	0.75	:	99.845 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.107 (%)	Power factor	0.70	:	10.296 (%)
Power factor	0.95	:	5.254 (%)	Power factor	0.65	:	10.848 (%)
Power factor	0.90	:	6.841 (%)	Power factor	0.60	:	11.327 (%)
Power factor	0.85	:	7.987 (%)	Power factor	0.55	:	11.745 (%)
Power factor	0.80	:	8.899 (%)	Power factor	0.50	:	12.108 (%)
Power factor	0.75	:	9.654 (%)	Power factor	0.25	:	13.287 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	5/16R	
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	327750	/ 151646	
Rated current (A)	HV / LV	:	1183.8	/ 2558.5	
Impedance voltage (V)		:	43514		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1134211		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1040834	0.1039766	0.1039184
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093

Output data

Copper loss	:	at 20 ℃	649277.5 (W)	at 85 ℃	815745.8 (W)
Stray loss	:	at 20 ℃	484933.5 (W)	at 85 ℃	385973.7 (W)
Load loss	:	at 85 ℃	1201719.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.179 (%)		
% Reactance voltage drop	:	at 85 ℃	13.276 (%)		
% Impedance voltage drop	:	at 85 ℃	13.277 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.765 (%)	Load factor	0.60	:	99.867 (%)
Load factor	1.10	:	99.790 (%)	Load factor	0.50	:	99.880 (%)
Load factor	1.00	:	99.806 (%)	Load factor	0.40	:	99.890 (%)
Load factor	0.90	:	99.822 (%)	Load factor	0.30	:	99.895 (%)
Load factor	0.80	:	99.838 (%)	Load factor	0.25	:	99.893 (%)
Load factor	0.75	:	99.845 (%)	Load factor	0.20	:	99.886 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.060 (%)	Power factor	0.70	:	10.026 (%)
Power factor	0.95	:	5.103 (%)	Power factor	0.65	:	10.566 (%)
Power factor	0.90	:	6.652 (%)	Power factor	0.60	:	11.034 (%)
Power factor	0.85	:	7.771 (%)	Power factor	0.55	:	11.441 (%)
Power factor	0.80	:	8.661 (%)	Power factor	0.50	:	11.797 (%)
Power factor	0.75	:	9.399 (%)	Power factor	0.25	:	12.948 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No. 20120871TKE001

Measurement on 403 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (LV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/16L	362250	642.3	643.0	30082	8.304	481871	534813
2/16L	353625	658.0	658.8	28513	8.063	477878	529514
3/16L	345000	674.4	674.9	27055	7.842	478468	527735
4/16L	336375	691.7	692.3	25887	7.696	483511	529379
5/16L	327750	709.9	710.0	24657	7.523	481360	525142

Correction on 535 MVA base

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/16L	362250	852.7	-	39936	11.025	-	942539
2/16L	353625	873.5	-	37852	10.704	-	933200
3/16L	345000	895.3	-	35916	10.411	-	930066
4/16L	336375	918.3	-	34366	10.217	-	932962
5/16L	327750	942.4	-	32734	9.988	-	925495

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

403 MVA BASE

LV Tap No : 16L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	642.3 A	643.2 A	V_1	17429 V	P_1	158287 W
I_2	642.3 A	643.5 A	V_2	17350 V	P_2	149808 W
I_3	642.3 A	642.3 A	V_3	17325 V	P_3	173776 W
I_{avg}	642.3 A	643.0 A	V_{avg}	17368 V	P_t	481871 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	658.0 A	659.0 A	V_1	16520 V	P_1	155636 W
I_2	658.0 A	659.3 A	V_2	16445 V	P_2	150488 W
I_3	658.0 A	658.1 A	V_3	16420 V	P_3	171754 W
I_{avg}	658.0 A	658.8 A	V_{avg}	16462 V	P_t	477878 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	674.4 A	675.1 A	V_1	15679 V	P_1	153676 W
I_2	674.4 A	675.0 A	V_2	15590 V	P_2	151388 W
I_3	674.4 A	674.6 A	V_3	15590 V	P_3	173404 W
I_{avg}	674.4 A	674.9 A	V_{avg}	15620 V	P_t	478468 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	691.7 A	692.0 A	V_1	15002 V	P_1	151094 W
I_2	691.7 A	692.5 A	V_2	14946 V	P_2	155724 W
I_3	691.7 A	692.3 A	V_3	14891 V	P_3	176693 W
I_{avg}	691.7 A	692.3 A	V_{avg}	14946 V	P_t	483511 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

403 MVA BASE

LV Tap No : 16L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	709.9 A	709.8 A	V_1	14245 V	P_1	148329 W
I_2	709.9 A	710.3 A	V_2	14248 V	P_2	155860 W
I_3	709.9 A	709.9 A	V_3	14215 V	P_3	177171 W
I_{avg}	709.9 A	710.0 A	V_{avg}	14236 V	P_t	481360 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/16L	
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	362250	/ 123650	
Rated current (A)	HV / LV	:	642.3	/ 1881.7	
Impedance voltage (V)		:	30082		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	481871		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1249022	0.1247599	0.1247610
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	328534.2 (W)	at 85 ℃	412767.1 (W)
Stray loss	:	at 20 ℃	153336.8 (W)	at 85 ℃	122045.5 (W)
Load loss	:	at 85 ℃	534812.7 (W)		
% Resistance voltage drop	:	at 85 ℃	0.133 (%)		
% Reactance voltage drop	:	at 85 ℃	8.303 (%)		
% Impedance voltage drop	:	at 85 ℃	8.304 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.814 (%)	Load factor	0.60	:	99.877 (%)
Load factor	1.10	:	99.831 (%)	Load factor	0.50	:	99.882 (%)
Load factor	1.00	:	99.842 (%)	Load factor	0.40	:	99.882 (%)
Load factor	0.90	:	99.852 (%)	Load factor	0.30	:	99.874 (%)
Load factor	0.80	:	99.862 (%)	Load factor	0.25	:	99.863 (%)
Load factor	0.75	:	99.866 (%)	Load factor	0.20	:	99.844 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.477 (%)	Power factor	0.70	:	6.186 (%)
Power factor	0.95	:	3.027 (%)	Power factor	0.65	:	6.537 (%)
Power factor	0.90	:	4.014 (%)	Power factor	0.60	:	6.841 (%)
Power factor	0.85	:	4.731 (%)	Power factor	0.55	:	7.107 (%)
Power factor	0.80	:	5.304 (%)	Power factor	0.50	:	7.339 (%)
Power factor	0.75	:	5.780 (%)	Power factor	0.25	:	8.092 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	2/16L	
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	353625	/ 123893	
Rated current (A)	HV / LV	:	658.0	/ 1878.0	
Impedance voltage (V)		:	28513		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	477878		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1196655	0.1195434	0.1195302
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	323928.4 (W)	at 85 ℃	406980.4 (W)
Stray loss	:	at 20 ℃	153949.6 (W)	at 85 ℃	122533.3 (W)
Load loss	:	at 85 ℃	529513.7 (W)		
% Resistance voltage drop	:	at 85 ℃	0.131 (%)		
% Reactance voltage drop	:	at 85 ℃	8.062 (%)		
% Impedance voltage drop	:	at 85 ℃	8.063 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.815 (%)	Load factor	0.60	:	99.878 (%)
Load factor	1.10	:	99.832 (%)	Load factor	0.50	:	99.882 (%)
Load factor	1.00	:	99.843 (%)	Load factor	0.40	:	99.883 (%)
Load factor	0.90	:	99.853 (%)	Load factor	0.30	:	99.874 (%)
Load factor	0.80	:	99.863 (%)	Load factor	0.25	:	99.863 (%)
Load factor	0.75	:	99.867 (%)	Load factor	0.20	:	99.844 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.456 (%)	Power factor	0.70	:	6.004 (%)
Power factor	0.95	:	2.932 (%)	Power factor	0.65	:	6.344 (%)
Power factor	0.90	:	3.892 (%)	Power factor	0.60	:	6.641 (%)
Power factor	0.85	:	4.589 (%)	Power factor	0.55	:	6.899 (%)
Power factor	0.80	:	5.145 (%)	Power factor	0.50	:	7.124 (%)
Power factor	0.75	:	5.609 (%)	Power factor	0.25	:	7.857 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	3/16L	
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	345000	/ 124150	
Rated current (A)	HV / LV	:	674.4	/ 1874.1	
Impedance voltage (V)		:	27055		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	478468		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1144483	0.1143317	0.1143075
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	319046.7 (W)	at 85 ℃	400847.1 (W)
Stray loss	:	at 20 ℃	159421.3 (W)	at 85 ℃	126888.4 (W)
Load loss	:	at 85 ℃	527735.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.131 (%)		
% Reactance voltage drop	:	at 85 ℃	7.841 (%)		
% Impedance voltage drop	:	at 85 ℃	7.842 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.816 (%)	Load factor	0.60	:	99.878 (%)
Load factor	1.10	:	99.833 (%)	Load factor	0.50	:	99.883 (%)
Load factor	1.00	:	99.843 (%)	Load factor	0.40	:	99.883 (%)
Load factor	0.90	:	99.853 (%)	Load factor	0.30	:	99.874 (%)
Load factor	0.80	:	99.863 (%)	Load factor	0.25	:	99.864 (%)
Load factor	0.75	:	99.867 (%)	Load factor	0.20	:	99.844 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.438 (%)	Power factor	0.70	:	5.837 (%)
Power factor	0.95	:	2.847 (%)	Power factor	0.65	:	6.169 (%)
Power factor	0.90	:	3.781 (%)	Power factor	0.60	:	6.457 (%)
Power factor	0.85	:	4.459 (%)	Power factor	0.55	:	6.709 (%)
Power factor	0.80	:	5.001 (%)	Power factor	0.50	:	6.928 (%)
Power factor	0.75	:	5.452 (%)	Power factor	0.25	:	7.642 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

input data	Tap position		HV/LV 4/16L		
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	336375	/ 124421	
Rated current (A)	HV / LV	:	691.7	/ 1870.0	
Impedance voltage (V)		:	25887		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	483511		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1092648	0.1091520	0.1091134
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	313898.9 (W)	at 85 ℃	394379.4 (W)
Stray loss	:	at 20 ℃	169612.1 (W)	at 85 ℃	134999.6 (W)
Load loss	:	at 85 ℃	529379.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.131 (%)		
% Reactance voltage drop	:	at 85 ℃	7.695 (%)		
% Impedance voltage drop	:	at 85 ℃	7.696 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.815 (%)	Load factor	0.60	:	99.878 (%)
Load factor	1.10	:	99.832 (%)	Load factor	0.50	:	99.882 (%)
Load factor	1.00	:	99.843 (%)	Load factor	0.40	:	99.883 (%)
Load factor	0.90	:	99.853 (%)	Load factor	0.30	:	99.874 (%)
Load factor	0.80	:	99.863 (%)	Load factor	0.25	:	99.863 (%)
Load factor	0.75	:	99.867 (%)	Load factor	0.20	:	99.844 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.427 (%)	Power factor	0.70	:	5.727 (%)
Power factor	0.95	:	2.792 (%)	Power factor	0.65	:	6.053 (%)
Power factor	0.90	:	3.708 (%)	Power factor	0.60	:	6.337 (%)
Power factor	0.85	:	4.375 (%)	Power factor	0.55	:	6.584 (%)
Power factor	0.80	:	4.907 (%)	Power factor	0.50	:	6.799 (%)
Power factor	0.75	:	5.350 (%)	Power factor	0.25	:	7.500 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	5/16L	
Capacity (kVA)		:	403000		
Rated voltage (V)	HV / LV	:	327750	/ 124708	
Rated current (A)	HV / LV	:	709.9	/ 1865.7	
Impedance voltage (V)		:	24657		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	481360		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1040834	0.1039766	0.1039184
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	308414.9 (W)	at 85 ℃	387489.4 (W)
Stray loss	:	at 20 ℃	172945.1 (W)	at 85 ℃	137652.4 (W)
Load loss	:	at 85 ℃	525141.8 (W)		
% Resistance voltage drop	:	at 85 ℃	0.130 (%)		
% Reactance voltage drop	:	at 85 ℃	7.522 (%)		
% Impedance voltage drop	:	at 85 ℃	7.523 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.817 (%)	Load factor	0.60	:	99.879 (%)
Load factor	1.10	:	99.833 (%)	Load factor	0.50	:	99.883 (%)
Load factor	1.00	:	99.844 (%)	Load factor	0.40	:	99.883 (%)
Load factor	0.90	:	99.854 (%)	Load factor	0.30	:	99.874 (%)
Load factor	0.80	:	99.863 (%)	Load factor	0.25	:	99.864 (%)
Load factor	0.75	:	99.868 (%)	Load factor	0.20	:	99.844 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.413 (%)	Power factor	0.70	:	5.597 (%)
Power factor	0.95	:	2.725 (%)	Power factor	0.65	:	5.916 (%)
Power factor	0.90	:	3.622 (%)	Power factor	0.60	:	6.193 (%)
Power factor	0.85	:	4.273 (%)	Power factor	0.55	:	6.435 (%)
Power factor	0.80	:	4.794 (%)	Power factor	0.50	:	6.646 (%)
Power factor	0.75	:	5.228 (%)	Power factor	0.25	:	7.331 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No. 20120871TKE001

Measurement on 672 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (LV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/16L	362250	1071.0	1071.4	50046	13.816	1348705	1494106
2/16L	353625	1097.1	1097.2	47410	13.407	1335708	1477864
3/16L	345000	1124.6	1125.3	45045	13.057	1342231	1476806
4/16L	336375	1153.4	1153.8	43000	12.784	1352043	1478025
5/16L	327750	1183.8	1184.2	40961	12.498	1349108	1468668

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

672 MVA BASE

LV Tap No : 16L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1071.0 A	1071.7 A	V_1	28996 V	P_1	442422 W
I_2	1071.0 A	1072.2 A	V_2	28863 V	P_2	419998 W
I_3	1071.0 A	1070.3 A	V_3	28823 V	P_3	486285 W
I_{avg}	1071.0 A	1071.4 A	V_{avg}	28894 V	P_t	1348705 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1097.1 A	1097.6 A	V_1	27470 V	P_1	434673 W
I_2	1097.1 A	1098.0 A	V_2	27343 V	P_2	421041 W
I_3	1097.1 A	1096.1 A	V_3	27303 V	P_3	479994 W
I_{avg}	1097.1 A	1097.2 A	V_{avg}	27372 V	P_t	1335708 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1124.6 A	1125.6 A	V_1	26106 V	P_1	432286 W
I_2	1124.6 A	1125.5 A	V_2	25958 V	P_2	424649 W
I_3	1124.6 A	1124.9 A	V_3	25957 V	P_3	485296 W
I_{avg}	1124.6 A	1125.3 A	V_{avg}	26007 V	P_t	1342231 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1153.4 A	1153.3 A	V_1	24902 V	P_1	421631 W
I_2	1153.4 A	1154.3 A	V_2	24793 V	P_2	436110 W
I_3	1153.4 A	1153.8 A	V_3	24784 V	P_3	494302 W
I_{avg}	1153.4 A	1153.8 A	V_{avg}	24826 V	P_t	1352043 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

672 MVA BASE

LV Tap No : 16L

Supply : HV Short : LV Open : TV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	1183.8 A	1183.8 A	V_1	23722 V	P_1	416687 W
I_2	1183.8 A	1184.8 A	V_2	23621 V	P_2	437788 W
I_3	1183.8 A	1184.1 A	V_3	23605 V	P_3	494633 W
I_{avg}	1183.8 A	1184.2 A	V_{avg}	23649 V	P_t	1349108 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/16L	
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	362250	/ 123650	
Rated current (A)	HV / LV	:	1071.0	/ 3137.7	
Impedance voltage (V)		:	50046		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1348705		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1249022	0.1247599	0.1247610
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	913501.1 (W)	at 85 ℃	1147713.7 (W)
Stray loss	:	at 20 ℃	435203.9 (W)	at 85 ℃	346392.4 (W)
Load loss	:	at 85 ℃	1494106.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.222 (%)		
% Reactance voltage drop	:	at 85 ℃	13.814 (%)		
% Impedance voltage drop	:	at 85 ℃	13.816 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.710 (%)	Load factor	0.60	:	99.841 (%)
Load factor	1.10	:	99.742 (%)	Load factor	0.50	:	99.858 (%)
Load factor	1.00	:	99.763 (%)	Load factor	0.40	:	99.872 (%)
Load factor	0.90	:	99.783 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.803 (%)	Load factor	0.25	:	99.882 (%)
Load factor	0.75	:	99.813 (%)	Load factor	0.20	:	99.878 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.176 (%)	Power factor	0.70	:	10.473 (%)
Power factor	0.95	:	5.377 (%)	Power factor	0.65	:	11.030 (%)
Power factor	0.90	:	6.982 (%)	Power factor	0.60	:	11.513 (%)
Power factor	0.85	:	8.142 (%)	Power factor	0.55	:	11.934 (%)
Power factor	0.80	:	9.062 (%)	Power factor	0.50	:	12.300 (%)
Power factor	0.75	:	9.825 (%)	Power factor	0.25	:	13.483 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/16L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	353625	/ 123893	
Rated current (A)	HV / LV	:	1097.1	/ 3131.6	
Impedance voltage (V)		:	47410		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1335708		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1196655	0.1195434	0.1195302
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	900694.4 (W)	at 85 ℃	1131623.5 (W)
Stray loss	:	at 20 ℃	435013.6 (W)	at 85 ℃	346240.9 (W)
Load loss	:	at 85 ℃	1477864.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.220 (%)		
% Reactance voltage drop	:	at 85 ℃	13.405 (%)		
% Impedance voltage drop	:	at 85 ℃	13.407 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.713 (%)	Load factor	0.60	:	99.842 (%)
Load factor	1.10	:	99.745 (%)	Load factor	0.50	:	99.859 (%)
Load factor	1.00	:	99.765 (%)	Load factor	0.40	:	99.873 (%)
Load factor	0.90	:	99.785 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.805 (%)	Load factor	0.25	:	99.883 (%)
Load factor	0.75	:	99.815 (%)	Load factor	0.20	:	99.878 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.118 (%)	Power factor	0.70	:	10.153 (%)
Power factor	0.95	:	5.197 (%)	Power factor	0.65	:	10.695 (%)
Power factor	0.90	:	6.757 (%)	Power factor	0.60	:	11.166 (%)
Power factor	0.85	:	7.885 (%)	Power factor	0.55	:	11.575 (%)
Power factor	0.80	:	8.780 (%)	Power factor	0.50	:	11.931 (%)
Power factor	0.75	:	9.523 (%)	Power factor	0.25	:	13.084 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	3/16L	
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	345000	/ 124150	
Rated current (A)	HV / LV	:	1124.6	/ 3125.1	
Impedance voltage (V)		:	45045		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1342231		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1144483	0.1143317	0.1143075
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	887120.6 (W)	at 85 ℃	1114569.5 (W)
Stray loss	:	at 20 ℃	455110.4 (W)	at 85 ℃	362236.6 (W)
Load loss	:	at 85 ℃	1476806.1 (W)		
% Resistance voltage drop	:	at 85 ℃	0.220 (%)		
% Reactance voltage drop	:	at 85 ℃	13.055 (%)		
% Impedance voltage drop	:	at 85 ℃	13.057 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.714 (%)	Load factor	0.60	:	99.842 (%)
Load factor	1.10	:	99.745 (%)	Load factor	0.50	:	99.859 (%)
Load factor	1.00	:	99.765 (%)	Load factor	0.40	:	99.873 (%)
Load factor	0.90	:	99.785 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.805 (%)	Load factor	0.25	:	99.883 (%)
Load factor	0.75	:	99.815 (%)	Load factor	0.20	:	99.878 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.072 (%)	Power factor	0.70	:	9.880 (%)
Power factor	0.95	:	5.046 (%)	Power factor	0.65	:	10.410 (%)
Power factor	0.90	:	6.567 (%)	Power factor	0.60	:	10.869 (%)
Power factor	0.85	:	7.667 (%)	Power factor	0.55	:	11.269 (%)
Power factor	0.80	:	8.541 (%)	Power factor	0.50	:	11.617 (%)
Power factor	0.75	:	9.265 (%)	Power factor	0.25	:	12.742 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 4/16L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	336375	/ 124421	
Rated current (A)	HV / LV	:	1153.4	/ 3118.3	
Impedance voltage (V)		:	43000		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1352043		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1092648	0.1091520	0.1091134
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	872806.9 (W)	at 85 ℃	1096586.0 (W)
Stray loss	:	at 20 ℃	479236.1 (W)	at 85 ℃	381438.9 (W)
Load loss	:	at 85 ℃	1478024.9 (W)		
% Resistance voltage drop	:	at 85 ℃	0.220 (%)		
% Reactance voltage drop	:	at 85 ℃	12.782 (%)		
% Impedance voltage drop	:	at 85 ℃	12.784 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.713 (%)	Load factor	0.60	:	99.842 (%)
Load factor	1.10	:	99.745 (%)	Load factor	0.50	:	99.859 (%)
Load factor	1.00	:	99.765 (%)	Load factor	0.40	:	99.873 (%)
Load factor	0.90	:	99.785 (%)	Load factor	0.30	:	99.882 (%)
Load factor	0.80	:	99.805 (%)	Load factor	0.25	:	99.883 (%)
Load factor	0.75	:	99.815 (%)	Load factor	0.20	:	99.878 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.037 (%)	Power factor	0.70	:	9.668 (%)
Power factor	0.95	:	4.929 (%)	Power factor	0.65	:	10.188 (%)
Power factor	0.90	:	6.420 (%)	Power factor	0.60	:	10.638 (%)
Power factor	0.85	:	7.498 (%)	Power factor	0.55	:	11.030 (%)
Power factor	0.80	:	8.354 (%)	Power factor	0.50	:	11.372 (%)
Power factor	0.75	:	9.065 (%)	Power factor	0.25	:	12.475 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 5/16L		
Capacity (kVA)		:	672000		
Rated voltage (V)	HV / LV	:	327750	/ 124708	
Rated current (A)	HV / LV	:	1183.8	/ 3111.1	
Impedance voltage (V)		:	40961		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	1349108		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-X1,H2-X2,H3-X3	:	0.1040834	0.1039766	0.1039184
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835

Output data

Copper loss	:	at 20 ℃	857558.6 (W)	at 85 ℃	1077428.1 (W)
Stray loss	:	at 20 ℃	491549.4 (W)	at 85 ℃	391239.5 (W)
Load loss	:	at 85 ℃	1468667.6 (W)		
% Resistance voltage drop	:	at 85 ℃	0.219 (%)		
% Reactance voltage drop	:	at 85 ℃	12.496 (%)		
% Impedance voltage drop	:	at 85 ℃	12.498 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.715 (%)	Load factor	0.60	:	99.843 (%)
Load factor	1.10	:	99.746 (%)	Load factor	0.50	:	99.860 (%)
Load factor	1.00	:	99.766 (%)	Load factor	0.40	:	99.874 (%)
Load factor	0.90	:	99.786 (%)	Load factor	0.30	:	99.883 (%)
Load factor	0.80	:	99.806 (%)	Load factor	0.25	:	99.883 (%)
Load factor	0.75	:	99.816 (%)	Load factor	0.20	:	99.879 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.999 (%)	Power factor	0.70	:	9.446 (%)
Power factor	0.95	:	4.806 (%)	Power factor	0.65	:	9.955 (%)
Power factor	0.90	:	6.265 (%)	Power factor	0.60	:	10.396 (%)
Power factor	0.85	:	7.320 (%)	Power factor	0.55	:	10.780 (%)
Power factor	0.80	:	8.159 (%)	Power factor	0.50	:	11.115 (%)
Power factor	0.75	:	8.855 (%)	Power factor	0.25	:	12.196 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No. 20120871TKE001

Measurement on 84.6 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (TV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/1L	362250	134.8	134.9	43542	12.020	110737	119816
2/1L	353625	138.1	138.3	41860	11.838	111235	120248
3/1L	345000	141.6	141.6	40580	11.763	111295	120333
4/1L	336375	145.2	145.5	39446	11.727	112002	120930
5/1L	327750	149.0	149.9	38382	11.711	113195	121916

Correction on 112.8 MVA base

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/1L	362250	179.8	-	58056	16.027	-	213005
2/1L	353625	184.2	-	55814	15.783	-	213774
3/1L	345000	188.8	-	54107	15.683	-	213925
4/1L	336375	193.6	-	52594	15.636	-	214987
5/1L	327750	198.7	-	51176	15.615	-	216739

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

84.6 MVA BASE

LV Tap No : 1L

Supply : HV Short : TV Open : LV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	134.8 A	134.6 A	V_1	25525 V	P_1	35051 W
I_2	134.8 A	135.3 A	V_2	24877 V	P_2	34346 W
I_3	134.8 A	134.6 A	V_3	25016 V	P_3	41340 W
I_{avg}	134.8 A	134.9 A	V_{avg}	25139 V	P_t	110737 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	138.1 A	138.1 A	V_1	24249 V	P_1	35273 W
I_2	138.1 A	138.8 A	V_2	24128 V	P_2	34697 W
I_3	138.1 A	138.1 A	V_3	24126 V	P_3	41265 W
I_{avg}	138.1 A	138.3 A	V_{avg}	24168 V	P_t	111235 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	141.6 A	141.4 A	V_1	23507 V	P_1	35217 W
I_2	141.6 A	142.1 A	V_2	23392 V	P_2	34743 W
I_3	141.6 A	141.4 A	V_3	23388 V	P_3	41335 W
I_{avg}	141.6 A	141.6 A	V_{avg}	23429 V	P_t	111295 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	145.2 A	145.3 A	V_1	22849 V	P_1	35063 W
I_2	145.2 A	146.0 A	V_2	22729 V	P_2	34974 W
I_3	145.2 A	145.3 A	V_3	22745 V	P_3	41964 W
I_{avg}	145.2 A	145.5 A	V_{avg}	22774 V	P_t	112002 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

84.6 MVA BASE

LV Tap No : 1L

Supply : HV Short : TV Open : LV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	149.0 A	149.6 A	V_1	22233 V	P_1	35331 W
I_2	149.0 A	150.4 A	V_2	22116 V	P_2	35368 W
I_3	149.0 A	149.7 A	V_3	22130 V	P_3	42496 W
I_{avg}	149.0 A	149.9 A	V_{avg}	22160 V	P_t	113195 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/1L
Capacity (kVA)		:	84600	
Rated voltage (V)	HV / TV	:	362250	/ 13145
Rated current (A)	HV / TV	:	134.8	/ 3715.8
Impedance voltage (V)		:	43542	
No-load losses (W)		:	104709	
Load losses (W)	19.8 ℃	:	110737	
Winding resistance	22.0 ℃			

HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1577841	0.1576180	0.1573300
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	68793.4 (W)	at 85 ℃	86431.4 (W)
Stray loss	:	at 20 ℃	41943.6 (W)	at 85 ℃	33384.2 (W)
Load loss	:	at 85 ℃	119815.6 (W)		
% Resistance voltage drop	:	at 85 ℃	0.142 (%)		
% Reactance voltage drop	:	at 85 ℃	12.019 (%)		
% Impedance voltage drop	:	at 85 ℃	12.020 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.725 (%)	Load factor	0.60	:	99.710 (%)
Load factor	1.10	:	99.732 (%)	Load factor	0.50	:	99.683 (%)
Load factor	1.00	:	99.735 (%)	Load factor	0.40	:	99.635 (%)
Load factor	0.90	:	99.736 (%)	Load factor	0.30	:	99.547 (%)
Load factor	0.80	:	99.733 (%)	Load factor	0.25	:	99.472 (%)
Load factor	0.75	:	99.729 (%)	Load factor	0.20	:	99.357 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.864 (%)	Power factor	0.70	:	9.028 (%)
Power factor	0.95	:	4.534 (%)	Power factor	0.65	:	9.523 (%)
Power factor	0.90	:	5.945 (%)	Power factor	0.60	:	9.952 (%)
Power factor	0.85	:	6.966 (%)	Power factor	0.55	:	10.327 (%)
Power factor	0.80	:	7.779 (%)	Power factor	0.50	:	10.653 (%)
Power factor	0.75	:	8.454 (%)	Power factor	0.25	:	11.714 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/1L		
Capacity (kVA)		:	84600		
Rated voltage (V)	HV / TV	:	353625	/ 13150	
Rated current (A)	HV / TV	:	138.1	/ 3714.4	
Impedance voltage (V)		:	41860		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	111235		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1525473	0.1524014	0.1520992
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	68871.7 (W)	at 85 ℃	86529.7 (W)
Stray loss	:	at 20 ℃	42363.3 (W)	at 85 ℃	33718.3 (W)
Load loss	:	at 85 ℃	120248.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.142 (%)		
% Reactance voltage drop	:	at 85 ℃	11.837 (%)		
% Impedance voltage drop	:	at 85 ℃	11.838 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.724 (%)	Load factor	0.60	:	99.709 (%)
Load factor	1.10	:	99.732 (%)	Load factor	0.50	:	99.682 (%)
Load factor	1.00	:	99.735 (%)	Load factor	0.40	:	99.635 (%)
Load factor	0.90	:	99.735 (%)	Load factor	0.30	:	99.547 (%)
Load factor	0.80	:	99.732 (%)	Load factor	0.25	:	99.472 (%)
Load factor	0.75	:	99.729 (%)	Load factor	0.20	:	99.357 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.843 (%)	Power factor	0.70	:	8.888 (%)
Power factor	0.95	:	4.458 (%)	Power factor	0.65	:	9.375 (%)
Power factor	0.90	:	5.848 (%)	Power factor	0.60	:	9.799 (%)
Power factor	0.85	:	6.855 (%)	Power factor	0.55	:	10.168 (%)
Power factor	0.80	:	7.656 (%)	Power factor	0.50	:	10.490 (%)
Power factor	0.75	:	8.322 (%)	Power factor	0.25	:	11.536 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/1L		
Capacity (kVA)		:	84600		
Rated voltage (V)	HV / TV	:	345000	/ 13155	
Rated current (A)	HV / TV	:	141.6	/ 3712.9	
Impedance voltage (V)		:	40580		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	111295		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1473301	0.1471897	0.1468765
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	68952.5 (W)	at 85 ℃	86631.3 (W)
Stray loss	:	at 20 ℃	42342.5 (W)	at 85 ℃	33701.7 (W)
Load loss	:	at 85 ℃	120333.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.142 (%)		
% Reactance voltage drop	:	at 85 ℃	11.762 (%)		
% Impedance voltage drop	:	at 85 ℃	11.763 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.724 (%)	Load factor	0.60	:	99.709 (%)
Load factor	1.10	:	99.732 (%)	Load factor	0.50	:	99.682 (%)
Load factor	1.00	:	99.735 (%)	Load factor	0.40	:	99.635 (%)
Load factor	0.90	:	99.735 (%)	Load factor	0.30	:	99.547 (%)
Load factor	0.80	:	99.732 (%)	Load factor	0.25	:	99.472 (%)
Load factor	0.75	:	99.729 (%)	Load factor	0.20	:	99.357 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.834 (%)	Power factor	0.70	:	8.830 (%)
Power factor	0.95	:	4.427 (%)	Power factor	0.65	:	9.315 (%)
Power factor	0.90	:	5.809 (%)	Power factor	0.60	:	9.736 (%)
Power factor	0.85	:	6.809 (%)	Power factor	0.55	:	10.103 (%)
Power factor	0.80	:	7.605 (%)	Power factor	0.50	:	10.423 (%)
Power factor	0.75	:	8.267 (%)	Power factor	0.25	:	11.463 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 4/1L.		
Capacity (kVA)		:	84600		
Rated voltage (V)	HV / TV	:	336375	/ 13161	
Rated current (A)	HV / TV	:	145.2	/ 3711.3	
Impedance voltage (V)		:	39446		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	112002		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1421466	0.1420100	0.1416824
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	69028.0 (W)	at 85 ℃	86726.1 (W)
Stray loss	:	at 20 ℃	42974.0 (W)	at 85 ℃	34204.3 (W)
Load loss	:	at 85 ℃	120930.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.143 (%)		
% Reactance voltage drop	:	at 85 ℃	11.726 (%)		
% Impedance voltage drop	:	at 85 ℃	11.727 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.723 (%)	Load factor	0.60	:	99.709 (%)
Load factor	1.10	:	99.731 (%)	Load factor	0.50	:	99.682 (%)
Load factor	1.00	:	99.734 (%)	Load factor	0.40	:	99.635 (%)
Load factor	0.90	:	99.735 (%)	Load factor	0.30	:	99.547 (%)
Load factor	0.80	:	99.732 (%)	Load factor	0.25	:	99.472 (%)
Load factor	0.75	:	99.729 (%)	Load factor	0.20	:	99.357 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.830 (%)	Power factor	0.70	:	8.803 (%)
Power factor	0.95	:	4.413 (%)	Power factor	0.65	:	9.286 (%)
Power factor	0.90	:	5.790 (%)	Power factor	0.60	:	9.706 (%)
Power factor	0.85	:	6.788 (%)	Power factor	0.55	:	10.072 (%)
Power factor	0.80	:	7.582 (%)	Power factor	0.50	:	10.391 (%)
Power factor	0.75	:	8.242 (%)	Power factor	0.25	:	11.428 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 5/1L		
Capacity (kVA)		:	84600		
Rated voltage (V)	HV / TV	:	327750	/ 13167	
Rated current (A)	HV / TV	:	149.0	/ 3709.6	
Impedance voltage (V)		:	38382		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	113195		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1369653	0.1368346	0.1364874
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	69105.5 (W)	at 85 ℃	86823.5 (W)
Stray loss	:	at 20 ℃	44089.5 (W)	at 85 ℃	35092.2 (W)
Load loss	:	at 85 ℃	121915.7 (W)		
% Resistance voltage drop	:	at 85 ℃	0.144 (%)		
% Reactance voltage drop	:	at 85 ℃	11.710 (%)		
% Impedance voltage drop	:	at 85 ℃	11.711 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.722 (%)	Load factor	0.60	:	99.708 (%)
Load factor	1.10	:	99.730 (%)	Load factor	0.50	:	99.681 (%)
Load factor	1.00	:	99.733 (%)	Load factor	0.40	:	99.634 (%)
Load factor	0.90	:	99.733 (%)	Load factor	0.30	:	99.546 (%)
Load factor	0.80	:	99.731 (%)	Load factor	0.25	:	99.472 (%)
Load factor	0.75	:	99.728 (%)	Load factor	0.20	:	99.356 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.830 (%)	Power factor	0.70	:	8.791 (%)
Power factor	0.95	:	4.407 (%)	Power factor	0.65	:	9.274 (%)
Power factor	0.90	:	5.783 (%)	Power factor	0.60	:	9.693 (%)
Power factor	0.85	:	6.779 (%)	Power factor	0.55	:	10.059 (%)
Power factor	0.80	:	7.572 (%)	Power factor	0.50	:	10.377 (%)
Power factor	0.75	:	8.231 (%)	Power factor	0.25	:	11.413 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No.
20120871TKE001

Measurement on 141 MVA base

at 60 Hz and 19.8 ℃, (HV) side connection, (TV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
1/1L	362250	224.7	224.9	71830	19.829	308785	333762
2/1L	353625	230.2	231.0	69890	19.764	310741	335419
3/1L	345000	236.0	236.2	67633	19.604	308871	334034
4/1L	336375	242.0	242.1	65615	19.507	310386	335336
5/1L	327750	248.4	248.9	63688	19.432	312067	336773

Date of Test : 2013. 02. 22 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

141 MVA BASE

LV Tap No : 1L

Supply : HV Short : TV Open : LV

Oil temp. : 19.8 ℃

Tap No. : 1

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	224.7 A	224.5 A	V_1	41613 V	P_1	98090 W
I_2	224.7 A	225.7 A	V_2	41402 V	P_2	96166 W
I_3	224.7 A	224.5 A	V_3	41397 V	P_3	114529 W
I_{avg}	224.7 A	224.9 A	V_{avg}	41471 V	P_t	308785 W

Tap No. : 2

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	230.2 A	230.6 A	V_1	40488 V	P_1	98179 W
I_2	230.2 A	231.8 A	V_2	40286 V	P_2	96905 W
I_3	230.2 A	230.5 A	V_3	40278 V	P_3	115657 W
I_{avg}	230.2 A	231.0 A	V_{avg}	40351 V	P_t	310741 W

Tap No. : 3

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	236.0 A	235.8 A	V_1	39182 V	P_1	97770 W
I_2	236.0 A	237.0 A	V_2	38984 V	P_2	96236 W
I_3	236.0 A	235.7 A	V_3	38977 V	P_3	114865 W
I_{avg}	236.0 A	236.2 A	V_{avg}	39048 V	P_t	308871 W

Tap No. : 4

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	242.0 A	241.7 A	V_1	38009 V	P_1	97122 W
I_2	242.0 A	242.9 A	V_2	37808 V	P_2	96756 W
I_3	242.0 A	241.8 A	V_3	37833 V	P_3	116508 W
I_{avg}	242.0 A	242.1 A	V_{avg}	37883 V	P_t	310386 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No.
20120871TKE001

141 MVA BASE

LV Tap No : 1L

Supply : HV Short : TV Open : LV

Oil temp. : 19.8 ℃

Tap No. : 5

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	248.4 A	248.3 A	V_1	36892 V	P_1	97644 W
I_2	248.4 A	249.6 A	V_2	36700 V	P_2	97329 W
I_3	248.4 A	248.4 A	V_3	36718 V	P_3	117094 W
I_{avg}	248.4 A	248.8 A	V_{avg}	36770 V	P_t	312067 W

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	1/1L
Capacity (kVA)		:	141000	
Rated voltage (V)	HV / TV	:	362250	/ 13145
Rated current (A)	HV / TV	:	224.7	/ 6193.0
Impedance voltage (V)		:	71830	
No-load losses (W)		:	104709	
Load losses (W)	19.8 ℃	:	308785	
Winding resistance	22.0 ℃			
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1577841	0.1576180 0.1573300
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303 0.0029533

Output data

Copper loss	:	at 20 ℃	191092.9 (W)	at 85 ℃	240087.2 (W)
Stray loss	:	at 20 ℃	117692.1 (W)	at 85 ℃	93674.8 (W)
Load loss	:	at 85 ℃	333762.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.237 (%)		
% Reactance voltage drop	:	at 85 ℃	19.828 (%)		
% Impedance voltage drop	:	at 85 ℃	19.829 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.646 (%)	Load factor	0.60	:	99.735 (%)
Load factor	1.10	:	99.673 (%)	Load factor	0.50	:	99.734 (%)
Load factor	1.00	:	99.690 (%)	Load factor	0.40	:	99.720 (%)
Load factor	0.90	:	99.705 (%)	Load factor	0.30	:	99.682 (%)
Load factor	0.80	:	99.719 (%)	Load factor	0.25	:	99.645 (%)
Load factor	0.75	:	99.724 (%)	Load factor	0.20	:	99.583 (%)

Calculation of voltage regulation

Power factor	1.00	:	2.202 (%)	Power factor	0.70	:	15.265 (%)
Power factor	0.95	:	8.176 (%)	Power factor	0.65	:	16.029 (%)
Power factor	0.90	:	10.430 (%)	Power factor	0.60	:	16.689 (%)
Power factor	0.85	:	12.045 (%)	Power factor	0.55	:	17.263 (%)
Power factor	0.80	:	13.322 (%)	Power factor	0.50	:	17.761 (%)
Power factor	0.75	:	14.375 (%)	Power factor	0.25	:	19.369 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 2/1L		
Capacity (kVA)		:	141000		
Rated voltage (V)	HV / TV	:	353625	/ 13150	
Rated current (A)	HV / TV	:	230.2	/ 6190.6	
Impedance voltage (V)		:	69890		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	310741		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1525473	0.1524014	0.1520992
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	191310.2 (W)	at 85 ℃	240360.3 (W)
Stray loss	:	at 20 ℃	119430.8 (W)	at 85 ℃	95058.7 (W)
Load loss	:	at 85 ℃	335418.9 (W)		
% Resistance voltage drop	:	at 85 ℃	0.238 (%)		
% Reactance voltage drop	:	at 85 ℃	19.763 (%)		
% Impedance voltage drop	:	at 85 ℃	19.764 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.645 (%)	Load factor	0.60	:	99.734 (%)
Load factor	1.10	:	99.672 (%)	Load factor	0.50	:	99.733 (%)
Load factor	1.00	:	99.689 (%)	Load factor	0.40	:	99.720 (%)
Load factor	0.90	:	99.704 (%)	Load factor	0.30	:	99.682 (%)
Load factor	0.80	:	99.718 (%)	Load factor	0.25	:	99.645 (%)
Load factor	0.75	:	99.723 (%)	Load factor	0.20	:	99.583 (%)

Calculation of voltage regulation

Power factor	1.00	:	2.191 (%)	Power factor	0.70	:	15.213 (%)
Power factor	0.95	:	8.145 (%)	Power factor	0.65	:	15.975 (%)
Power factor	0.90	:	10.392 (%)	Power factor	0.60	:	16.633 (%)
Power factor	0.85	:	12.003 (%)	Power factor	0.55	:	17.205 (%)
Power factor	0.80	:	13.275 (%)	Power factor	0.50	:	17.702 (%)
Power factor	0.75	:	14.325 (%)	Power factor	0.25	:	19.306 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/1L		
Capacity (kVA)		:	141000		
Rated voltage (V)	HV / TV	:	345000	/	13155
Rated current (A)	HV / TV	:	236.0	/	6188.2
Impedance voltage (V)		:	67633		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	308871		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1473301	0.1471897	0.1468765
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	191534.8 (W)	at 85 ℃	240642.4 (W)
Stray loss	:	at 20 ℃	117336.2 (W)	at 85 ℃	93391.6 (W)
Load loss	:	at 85 ℃	334033.9 (W)		
% Resistance voltage drop	:	at 85 ℃	0.237 (%)		
% Reactance voltage drop	:	at 85 ℃	19.603 (%)		
% Impedance voltage drop	:	at 85 ℃	19.604 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.646 (%)	Load factor	0.60	:	99.735 (%)
Load factor	1.10	:	99.673 (%)	Load factor	0.50	:	99.734 (%)
Load factor	1.00	:	99.690 (%)	Load factor	0.40	:	99.720 (%)
Load factor	0.90	:	99.705 (%)	Load factor	0.30	:	99.682 (%)
Load factor	0.80	:	99.718 (%)	Load factor	0.25	:	99.645 (%)
Load factor	0.75	:	99.724 (%)	Load factor	0.20	:	99.583 (%)

Calculation of voltage regulation

Power factor	1.00	:	2.158 (%)	Power factor	0.70	:	15.083 (%)
Power factor	0.95	:	8.066 (%)	Power factor	0.65	:	15.840 (%)
Power factor	0.90	:	10.296 (%)	Power factor	0.60	:	16.494 (%)
Power factor	0.85	:	11.895 (%)	Power factor	0.55	:	17.062 (%)
Power factor	0.80	:	13.159 (%)	Power factor	0.50	:	17.555 (%)
Power factor	0.75	:	14.201 (%)	Power factor	0.25	:	19.148 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 4/1L		
Capacity (kVA)		:	141000		
Rated voltage (V)	HV / TV	:	336375	/ 13161	
Rated current (A)	HV / TV	:	242.0	/ 6185.4	
Impedance voltage (V)		:	65615		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	310386		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1421466	0.1420100	0.1416824
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	191744.5 (W)	at 85 ℃	240905.9 (W)
Stray loss	:	at 20 ℃	118641.5 (W)	at 85 ℃	94430.4 (W)
Load loss	:	at 85 ℃	335336.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.238 (%)		
% Reactance voltage drop	:	at 85 ℃	19.505 (%)		
% Impedance voltage drop	:	at 85 ℃	19.507 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.645 (%)	Load factor	0.60	:	99.734 (%)
Load factor	1.10	:	99.672 (%)	Load factor	0.50	:	99.733 (%)
Load factor	1.00	:	99.689 (%)	Load factor	0.40	:	99.720 (%)
Load factor	0.90	:	99.704 (%)	Load factor	0.30	:	99.682 (%)
Load factor	0.80	:	99.718 (%)	Load factor	0.25	:	99.645 (%)
Load factor	0.75	:	99.723 (%)	Load factor	0.20	:	99.583 (%)

Calculation of voltage regulation

Power factor	1.00	:	2.140 (%)	Power factor	0.70	:	15.005 (%)
Power factor	0.95	:	8.020 (%)	Power factor	0.65	:	15.758 (%)
Power factor	0.90	:	10.239 (%)	Power factor	0.60	:	16.410 (%)
Power factor	0.85	:	11.831 (%)	Power factor	0.55	:	16.975 (%)
Power factor	0.80	:	13.089 (%)	Power factor	0.50	:	17.467 (%)
Power factor	0.75	:	14.127 (%)	Power factor	0.25	:	19.053 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 5/1L		
Capacity (kVA)		:	141000		
Rated voltage (V)	HV / TV	:	327750	/ 13167	
Rated current (A)	HV / TV	:	248.4	/ 6182.6	
Impedance voltage (V)		:	63688		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	312067		
Winding resistance	22.0 ℃				
HV winding(ohm)	H1-H0X0,H2-H0X0,H3-H0X0	:	0.1369653	0.1368346	0.1364874
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	191959.7 (W)	at 85 ℃	241176.3 (W)
Stray loss	:	at 20 ℃	120107.3 (W)	at 85 ℃	95597.1 (W)
Load loss	:	at 85 ℃	336773.4 (W)		
% Resistance voltage drop	:	at 85 ℃	0.239 (%)		
% Reactance voltage drop	:	at 85 ℃	19.430 (%)		
% Impedance voltage drop	:	at 85 ℃	19.432 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.643 (%)	Load factor	0.60	:	99.734 (%)
Load factor	1.10	:	99.671 (%)	Load factor	0.50	:	99.733 (%)
Load factor	1.00	:	99.688 (%)	Load factor	0.40	:	99.720 (%)
Load factor	0.90	:	99.703 (%)	Load factor	0.30	:	99.682 (%)
Load factor	0.80	:	99.717 (%)	Load factor	0.25	:	99.645 (%)
Load factor	0.75	:	99.723 (%)	Load factor	0.20	:	99.583 (%)

Calculation of voltage regulation

Power factor	1.00	:	2.127 (%)	Power factor	0.70	:	14.945 (%)
Power factor	0.95	:	7.984 (%)	Power factor	0.65	:	15.696 (%)
Power factor	0.90	:	10.195 (%)	Power factor	0.60	:	16.345 (%)
Power factor	0.85	:	11.782 (%)	Power factor	0.55	:	16.909 (%)
Power factor	0.80	:	13.035 (%)	Power factor	0.50	:	17.399 (%)
Power factor	0.75	:	14.070 (%)	Power factor	0.25	:	18.980 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No. 20120871TKE001

Measurement on 84.6 MVA base

at 60 Hz and 19.8 ℃, (LV) side connection, (TV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
3/16R	152062	321.2	321.2	15715	10.335	119188	132134
3/1L	138175	353.5	353.6	13297	9.623	107013	118494
3/16L	124150	393.4	393.4	11556	9.308	106041	116839

Correction on 112.8 MVA base

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
3/16R	152062	428.3	-	20953	13.780	-	234905
3/1L	138175	471.3	-	17729	12.831	-	210656
3/16L	124150	471.3	-	15408	12.411	-	207714

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

84.6 MVA BASE

HV Tap No : 3

Supply : LV Short : TV Open : HV

Oil temp. : 19.8 ℃

Tap No. : 16R

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	321.0 A	320.4 A	V_1	9113 V	P_1	41048 W
I_2	321.0 A	322.4 A	V_2	9040 V	P_2	37458 W
I_3	321.0 A	320.8 A	V_3	9066 V	P_3	40682 W
I_{avg}	321.0 A	321.2 A	V_{avg}	9073 V	P_t	119188 W

Tap No. : 1L

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	353.5 A	353.1 A	V_1	7733 V	P_1	36463 W
I_2	353.5 A	354.4 A	V_2	7615 V	P_2	33278 W
I_3	353.5 A	353.2 A	V_3	7682 V	P_3	37272 W
I_{avg}	353.5 A	353.6 A	V_{avg}	7677 V	P_t	107013 W

Tap No. : 16L

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	393.4 A	393.5 A	V_1	6705 V	P_1	36058 W
I_2	393.4 A	393.5 A	V_2	6640 V	P_2	33645 W
I_3	393.4 A	393.1 A	V_3	6672 V	P_3	36337 W
I_{avg}	393.4 A	393.4 A	V_{avg}	6672 V	P_t	106041 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/16R		
Capacity (kVA)		:	84600		
Rated voltage (V)	LV / TV	:	152062	/ 12272	
Rated current (A)	LV / TV	:	321.2	/ 3980.1	
Impedance voltage (V)		:	15715		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	119188		
Winding resistance	22.0 ℃				
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	80937.9 (W)	at 85 ℃	101689.6 (W)
Stray loss	:	at 20 ℃	38250.1 (W)	at 85 ℃	30444.5 (W)
Load loss	:	at 85 ℃	132134.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.156 (%)		
% Reactance voltage drop	:	at 85 ℃	10.334 (%)		
% Impedance voltage drop	:	at 85 ℃	10.335 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.707 (%)	Load factor	0.60	:	99.701 (%)
Load factor	1.10	:	99.716 (%)	Load factor	0.50	:	99.675 (%)
Load factor	1.00	:	99.721 (%)	Load factor	0.40	:	99.629 (%)
Load factor	0.90	:	99.723 (%)	Load factor	0.30	:	99.543 (%)
Load factor	0.80	:	99.721 (%)	Load factor	0.25	:	99.469 (%)
Load factor	0.75	:	99.719 (%)	Load factor	0.20	:	99.354 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.690 (%)	Power factor	0.70	:	7.743 (%)
Power factor	0.95	:	3.852 (%)	Power factor	0.65	:	8.172 (%)
Power factor	0.90	:	5.071 (%)	Power factor	0.60	:	8.545 (%)
Power factor	0.85	:	5.955 (%)	Power factor	0.55	:	8.870 (%)
Power factor	0.80	:	6.659 (%)	Power factor	0.50	:	9.154 (%)
Power factor	0.75	:	7.245 (%)	Power factor	0.25	:	10.074 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	3/1L	
Capacity (kVA)		:	84600		
Rated voltage (V)	LV / TV	:	138175	/	13155
Rated current (A)	LV / TV	:	353.5	/	3712.9
Impedance voltage (V)		:	13297		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	107013		
Winding resistance	22.0 ℃				
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	72360.1 (W)	at 85 ℃	90912.6 (W)
Stray loss	:	at 20 ℃	34652.9 (W)	at 85 ℃	27581.3 (W)
Load loss	:	at 85 ℃	118493.9 (W)		
% Resistance voltage drop	:	at 85 ℃	0.140 (%)		
% Reactance voltage drop	:	at 85 ℃	9.622 (%)		
% Impedance voltage drop	:	at 85 ℃	9.623 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.727 (%)	Load factor	0.60	:	99.711 (%)
Load factor	1.10	:	99.734 (%)	Load factor	0.50	:	99.683 (%)
Load factor	1.00	:	99.737 (%)	Load factor	0.40	:	99.636 (%)
Load factor	0.90	:	99.737 (%)	Load factor	0.30	:	99.547 (%)
Load factor	0.80	:	99.734 (%)	Load factor	0.25	:	99.473 (%)
Load factor	0.75	:	99.731 (%)	Load factor	0.20	:	99.357 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.603 (%)	Power factor	0.70	:	7.190 (%)
Power factor	0.95	:	3.551 (%)	Power factor	0.65	:	7.592 (%)
Power factor	0.90	:	4.690 (%)	Power factor	0.60	:	7.942 (%)
Power factor	0.85	:	5.516 (%)	Power factor	0.55	:	8.247 (%)
Power factor	0.80	:	6.175 (%)	Power factor	0.50	:	8.513 (%)
Power factor	0.75	:	6.723 (%)	Power factor	0.25	:	9.378 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV	3/16L	
Capacity (kVA)		:	84600		
Rated voltage (V)	LV / TV	:	124150	/	14048
Rated current (A)	LV / TV	:	393.4	/	3476.9
Impedance voltage (V)		:	11556		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	106041		
Winding resistance	22.0 ℃				
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	70446.2 (W)	at 85 ℃	88507.9 (W)
Stray loss	:	at 20 ℃	35594.8 (W)	at 85 ℃	28331.0 (W)
Load loss	:	at 85 ℃	116838.9 (W)		
% Resistance voltage drop	:	at 85 ℃	0.138 (%)		
% Reactance voltage drop	:	at 85 ℃	9.307 (%)		
% Impedance voltage drop	:	at 85 ℃	9.308 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.729 (%)	Load factor	0.60	:	99.712 (%)
Load factor	1.10	:	99.736 (%)	Load factor	0.50	:	99.684 (%)
Load factor	1.00	:	99.739 (%)	Load factor	0.40	:	99.637 (%)
Load factor	0.90	:	99.739 (%)	Load factor	0.30	:	99.548 (%)
Load factor	0.80	:	99.736 (%)	Load factor	0.25	:	99.473 (%)
Load factor	0.75	:	99.732 (%)	Load factor	0.20	:	99.358 (%)

Calculation of voltage regulation

Power factor	1.00	:	0.571 (%)	Power factor	0.70	:	6.949 (%)
Power factor	0.95	:	3.425 (%)	Power factor	0.65	:	7.340 (%)
Power factor	0.90	:	4.527 (%)	Power factor	0.60	:	7.679 (%)
Power factor	0.85	:	5.328 (%)	Power factor	0.55	:	7.974 (%)
Power factor	0.80	:	5.966 (%)	Power factor	0.50	:	8.232 (%)
Power factor	0.75	:	6.497 (%)	Power factor	0.25	:	9.070 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & Impedance voltage

Serial No.
20120871TKE001

Measurement on 141 MVA base

at 60 Hz and 19.8 ℃, (LV) side connection, (TV) side short circuit.

Tap No. (HV/LV)	Rated Voltage(V)	Current (A)		Impedance		Load losses (W)	
		Rated	Test	Volt(V)	% at 85 ℃	at 19.8 ℃	at 85 ℃
3/16R	152062	535.3	535.3	26145	17.194	331331	367240
3/1L	138175	589.2	589.6	22063	15.968	297475	329322
3/16L	124150	655.7	656.6	19283	15.532	295257	325109

Date of Test : 2013. 02. 22

Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Load losses & impedance voltage

Serial No. 20120871TKE001

141 MVA BASE

HV Tap No : 3

Supply : LV Short : TV Open : HV

Oil temp. : 19.8 ℃

Tap No. : 16R

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	535.3 A	534.1 A	V_1	15152 V	P_1	113707 W
I_2	535.3 A	537.3 A	V_2	15057 V	P_2	103237 W
I_3	535.3 A	534.6 A	V_3	15076 V	P_3	114387 W
I_{avg}	535.3 A	535.3 A	V_{avg}	15095 V	P_t	331331 W

Tap No. : 1L

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	589.2 A	588.9 A	V_1	12791 V	P_1	100895 W
I_2	589.2 A	591.0 A	V_2	12694 V	P_2	92967 W
I_3	589.2 A	589.0 A	V_3	12729 V	P_3	103613 W
I_{avg}	589.2 A	589.6 A	V_{avg}	12738 V	P_t	297475 W

Tap No. : 16L

Rated current		Test current	Impedance voltage (rms) Phase to Ground		Losses	
I_1	655.7 A	656.8 A	V_1	11188 V	P_1	100233 W
I_2	655.7 A	656.8 A	V_2	11078 V	P_2	93937 W
I_3	655.7 A	656.2 A	V_3	11133 V	P_3	101087 W
I_{avg}	655.7 A	656.6 A	V_{avg}	11133 V	P_t	295257 W

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/16R		
Capacity (kVA)		:	141000		
Rated voltage (V)	LV / TV	:	152062	/ 12272	
Rated current (A)	LV / TV	:	535.3	/ 6633.5	
Impedance voltage (V)		:	26145		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	331331		
Winding resistance	22.0 ℃				
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387254	0.0384744	0.0380093
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	224827.4 (W)	at 85 ℃	282471.0 (W)
Stray loss	:	at 20 ℃	106503.6 (W)	at 85 ℃	84769.5 (W)
Load loss	:	at 85 ℃	367240.5 (W)		
% Resistance voltage drop	:	at 85 ℃	0.260 (%)		
% Reactance voltage drop	:	at 85 ℃	17.192 (%)		
% Impedance voltage drop	:	at 85 ℃	17.194 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.616 (%)	Load factor	0.60	:	99.721 (%)
Load factor	1.10	:	99.647 (%)	Load factor	0.50	:	99.722 (%)
Load factor	1.00	:	99.666 (%)	Load factor	0.40	:	99.711 (%)
Load factor	0.90	:	99.684 (%)	Load factor	0.30	:	99.675 (%)
Load factor	0.80	:	99.700 (%)	Load factor	0.25	:	99.639 (%)
Load factor	0.75	:	99.707 (%)	Load factor	0.20	:	99.578 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.738 (%)	Power factor	0.70	:	13.162 (%)
Power factor	0.95	:	6.936 (%)	Power factor	0.65	:	13.837 (%)
Power factor	0.90	:	8.908 (%)	Power factor	0.60	:	14.421 (%)
Power factor	0.85	:	10.326 (%)	Power factor	0.55	:	14.928 (%)
Power factor	0.80	:	11.448 (%)	Power factor	0.50	:	15.369 (%)
Power factor	0.75	:	12.376 (%)	Power factor	0.25	:	16.793 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	Tap position		HV/LV 3/1L		
Capacity (kVA)		:	141000		
Rated voltage (V)	LV / TV	:	138175	/ 13155	
Rated current (A)	LV / TV	:	589.2	/ 6188.2	
Impedance voltage (V)		:	22063		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	297475		
Winding resistance	22.0 ℃				
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0328819	0.0328580	0.0325690
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	201000.4 (W)	at 85 ℃	252534.9 (W)
Stray loss	:	at 20 ℃	96474.6 (W)	at 85 ℃	76787.2 (W)
Load loss	:	at 85 ℃	329322.0 (W)		
% Resistance voltage drop	:	at 85 ℃	0.234 (%)		
% Reactance voltage drop	:	at 85 ℃	15.966 (%)		
% Impedance voltage drop	:	at 85 ℃	15.968 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.650 (%)	Load factor	0.60	:	99.737 (%)
Load factor	1.10	:	99.677 (%)	Load factor	0.50	:	99.735 (%)
Load factor	1.00	:	99.693 (%)	Load factor	0.40	:	99.722 (%)
Load factor	0.90	:	99.708 (%)	Load factor	0.30	:	99.683 (%)
Load factor	0.80	:	99.721 (%)	Load factor	0.25	:	99.646 (%)
Load factor	0.75	:	99.727 (%)	Load factor	0.20	:	99.584 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.508 (%)	Power factor	0.70	:	12.171 (%)
Power factor	0.95	:	6.346 (%)	Power factor	0.65	:	12.805 (%)
Power factor	0.90	:	8.187 (%)	Power factor	0.60	:	13.354 (%)
Power factor	0.85	:	9.513 (%)	Power factor	0.55	:	13.831 (%)
Power factor	0.80	:	10.564 (%)	Power factor	0.50	:	14.246 (%)
Power factor	0.75	:	11.434 (%)	Power factor	0.25	:	15.588 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of load losses and characteristics

Serial No. 20120871TKE001

Input data	**Tap position**		**HV/LV**	**3/16L**	
Capacity (kVA)		:	141000		
Rated voltage (V)	LV / TV	:	124150	/ 14048	
Rated current (A)	LV / TV	:	655.7	/ 5794.9	
Impedance voltage (V)		:	19283		
No-load losses (W)		:	104709		
Load losses (W)	19.8 ℃	:	295257		
Winding resistance	22.0 ℃				
LV winding(ohm)	X1-H0X0,X2-H0X0,X3-H0X0	:	0.0387164	0.0384668	0.0379835
TV winding(ohm)	Y1-Y2,Y2-Y3,Y3-Y1	:	0.0029228	0.0029303	0.0029533

Output data

Copper loss	:	at 20 ℃	195683.9 (W)	at 85 ℃	245855.4 (W)
Stray loss	:	at 20 ℃	99573.1 (W)	at 85 ℃	79253.3 (W)
Load loss	:	at 85 ℃	325108.7 (W)		
% Resistance voltage drop	:	at 85 ℃	0.231 (%)		
% Reactance voltage drop	:	at 85 ℃	15.531 (%)		
% Impedance voltage drop	:	at 85 ℃	15.532 (%)		

Calculation of efficiency (PF : 1.0)

Load factor	1.25	:	99.654 (%)	Load factor	0.60	:	99.739 (%)
Load factor	1.10	:	99.680 (%)	Load factor	0.50	:	99.737 (%)
Load factor	1.00	:	99.696 (%)	Load factor	0.40	:	99.723 (%)
Load factor	0.90	:	99.711 (%)	Load factor	0.30	:	99.684 (%)
Load factor	0.80	:	99.723 (%)	Load factor	0.25	:	99.647 (%)
Load factor	0.75	:	99.729 (%)	Load factor	0.20	:	99.584 (%)

Calculation of voltage regulation

Power factor	1.00	:	1.437 (%)	Power factor	0.70	:	11.826 (%)
Power factor	0.95	:	6.146 (%)	Power factor	0.65	:	12.444 (%)
Power factor	0.90	:	7.940 (%)	Power factor	0.60	:	12.980 (%)
Power factor	0.85	:	9.233 (%)	Power factor	0.55	:	13.446 (%)
Power factor	0.80	:	10.258 (%)	Power factor	0.50	:	13.851 (%)
Power factor	0.75	:	11.106 (%)	Power factor	0.25	:	15.162 (%)

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of Three winding Load losses

Serial No. 20120871TKE001

Tap No. : 1/16L (HV : 403.0 MVA, LV : 403.0 MVA, TV : 5.00 MVA)

1) Measured load loss at 85 ℃

-. Pk H-X = 534812.7 (W) at 403.00 MVA base
-. Pk H-Y = 418.5 (W) at 5.00 MVA base
-. Pk X-Y = 408.1 (W) at 5.00 MVA base

2) Correction to 5.00 MVA base

-. Pk' H-L = Pk H-X X (Correction capacity/Measured capacity)^2 = 82.3 (W)

-. Pk' H-T = Pk H-Y ---------- = 418.5 (W)

-. Pk' L-T = Pk X-Y ---------- = 408.1 (W)

2) Each winding load losses to 5.00 MVA base

-. $Pk'\ H = \frac{Pk'\ H\text{-}L + Pk'\ H\text{-}T - Pk'\ L\text{-}T}{2} = \frac{82.3 + 418.5 - 408.1}{2} = 46.4$ (W)

-. $Pk'\ L = \frac{Pk'\ H\text{-}L + Pk'\ L\text{-}T - Pk'\ H\text{-}T}{2} = \frac{82.3 + 408.1 - 418.5}{2} = 36.0$ (W)

-. $Pk'\ T = \frac{Pk'\ H\text{-}T + Pk'\ L\text{-}T - Pk'\ H\text{-}L}{2} = \frac{418.5 + 408.1 - 82.3}{2} = 372.1$ (W)

3) Correction to each winding load losses

-. HV winding at 403.00 MVA base

$$\mathbf{Pk\ H'} = Pk'\ H \times \frac{\text{HV winding capacity}}{\text{Each winding capacity}} \quad 46.4 \times \left(\frac{403.00}{5.00}\right)^2 = \mathbf{301187.4}\ (W)$$

-. LV winding at 403.00 MVA base

$$\mathbf{Pk'\ L} = Pk'\ L \times \frac{\text{LV winding capacity}}{\text{Each winding capacity}} \quad 36.0 \times \left(\frac{403.00}{5.00}\right)^2 = \mathbf{233625.3}\ (W)$$

-. TV winding at 5.00 MVA base

Pk T' = **Pk' T** ---------- = **372.1** (W)

4) Three winding load losses at 85 ℃

∴ **Pk Total** = Pk H' + Pk L' + Pk T'

Pk(H+L+T) **Total** : 301187.4 + 233625.3 + 372.1 = **535184.8 (W)**

Date of Test : 2013. 02. 22 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Calculation of Three winding Load losses

Serial No. 20120871TKE001

Tap No. : 1/16L (HV : 672.0 MVA, LV : 672.0 MVA, TV : 5.00 MVA)

1) Measured load loss at 85 ℃

-. Pk H-L = 1494106.0 (W) at 672.00 MVA base
-. Pk H-T = 418.5 (W) at 5.00 MVA base
-. Pk L-T = 408.1 (W) at 5.00 MVA base

2) Correction to 5.00 MVA base

-. Pk' H-L = Pk H-L X (Correction capacity/Measured capacity)^2 = 82.7 (W)

-. Pk' H-T = Pk H-T ---------- = 418.5 (W)

-. Pk' L-T = Pk L-T ---------- = 408.1 (W)

2) Each winding load losses to 5.00 MVA base

-. $Pk'H = \frac{Pk'H\text{-}L + Pk'H\text{-}T - Pk'L\text{-}T}{2} = \frac{82.7 + 418.5 - 408.1}{2} = 46.6$ (W)

-. $Pk'L = \frac{Pk'H\text{-}L + Pk'L\text{-}T - Pk'H\text{-}T}{2} = \frac{82.7 + 408.1 - 418.5}{2} = 36.2$ (W)

-. $Pk'T = \frac{Pk'H\text{-}T + Pk'L\text{-}T - Pk'H\text{-}L}{2} = \frac{418.5 + 408.1 - 82.7}{2} = 371.9$ (W)

3) Correction to each winding load losses

-. HV winding at 672.00 MVA base

$$\mathbf{Pk\,H'} = Pk'H \times \frac{\text{HV winding capacity}}{\text{Each winding capacity}} \quad 46.6 \times \left(\frac{672.00}{5.00}\right)^2 = \mathbf{840982.5}\ (W)$$

-. LV winding at 672.00 MVA base

$$\mathbf{Pk'\,L} = Pk'L \times \frac{\text{LV winding capacity}}{\text{Each winding capacity}} \quad 36.2 \times \left(\frac{672.00}{5.00}\right)^2 = \mathbf{653123.6}\ (W)$$

-. TV winding at 5.00 MVA base

Pk' T = _____ = **371.9** (W)

4) Three winding load losses at 85 ℃

∴ **Pk Total** = Pk H' + Pk L' + Pk T'

Pk(H+L+T) Total : 840982.5 + 653123.6 + 371.9 = **1494478.0 (W)**

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Zero sequence impedance

Serial No. 20120871TKE001

403 MVA base

1. Test circuit : Supply : HV Open : LV, TV

1) Tap No.	:	3 / 1L
2) Rated current	:	674.4 (A)
3) Rated voltage	:	345000 (V)
4) Supply current	:	225 (A)
5) Measured voltage	:	11710.6 (V)

2. Correction zero sequence impedance voltage (V)

$$= \text{Measured voltage} \times \frac{(\text{Rated current} \times 3)}{\text{Supply current}}$$

$$= 11710.6 \times \frac{(674.4 \times 3)}{225}$$

$$= \mathbf{105301.7\ (V)}$$

3. Zero sequence impedance (%)

$$= 300 \times \left(\frac{\text{Measured voltage}}{\text{Rated voltage} / \sqrt{3}}\right) \times \left(\frac{\text{Rated current}}{\text{Supply current}}\right)$$

$$= 300 \times \left(\frac{11710.6}{345000 / \sqrt{3}}\right) \times \left(\frac{674.4}{225}\right)$$

$$= \mathbf{52.866\ (\%)}$$

4. Ohm / Phase

$$= \frac{(\text{Measured voltage} \times 3)}{\text{Supply currnet}}$$

$$= \frac{11710.6 \times 3}{225}$$

$$= \mathbf{156.14\ (\Omega)}$$

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Zero sequence impedance

Serial No.
20120871TKE001

403 MVA base

1. Test circuit : Supply : HV Short : LV Open : TV

1) Tap No.	:	3 / 1L
2) Rated current	:	674.4 (A)
3) Rated voltage	:	345000 (V)
4) Supply current	:	225.4 (A)
5) Measured voltage	:	1764.9 (V)

2. Correction zero sequence impedance voltage (V)

$$= \text{Measured voltage} \times \frac{(\text{Rated current} \times 3)}{\text{Supply current}}$$

$$= 1764.9 \times \frac{(674.4 \times 3)}{225.4}$$

$$= \mathbf{15841.8\ (V)}$$

3. Zero sequence impedance (%)

$$= 300 \times \left(\frac{\text{Measured voltage}}{\text{Rated voltage} / \sqrt{3}}\right) \times \left(\frac{\text{Rated current}}{\text{Supply current}}\right)$$

$$= 300 \times \left(\frac{1764.9}{345000 / \sqrt{3}}\right) \times \left(\frac{674.4}{225.4}\right)$$

$$= \mathbf{7.953\ (\%)}$$

4. Ohm / Phase

$$= \frac{(\text{Measured voltage} \times 3)}{\text{Supply currnet}}$$

$$= \frac{1764.9 \times 3}{225.4}$$

$$= \mathbf{23.49\ (\Omega)}$$

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Zero sequence impedance

Serial No.
20120871TKE001

403 MVA base

1. Test circuit : Supply : LV Open : HV, TV

1) Tap No.	:	3 / 1L
2) Rated current	:	1683.9 (A)
3) Rated voltage	:	138175 (V)
4) Supply current	:	400.7 (A)
5) Measured voltage	:	2742.4 (V)

2. Correction zero sequence impedance voltage (V)

$$= \text{Measured voltage} \times \frac{(\text{Rated current} \times 3)}{\text{Supply current}}$$

$$= 2742.4 \times \frac{(1683.9 \times 3)}{400.7}$$

$$= \mathbf{34574.0\ (V)}$$

3. Zero sequence impedance (%)

$$= 300 \times \left(\frac{\text{Measured voltage}}{\text{Rated voltage} / \sqrt{3}}\right) \times \left(\frac{\text{Rated current}}{\text{Supply current}}\right)$$

$$= 300 \times \left(\frac{2742.4}{138175 / \sqrt{3}}\right) \times \left(\frac{1683.9}{400.7}\right)$$

$$= \mathbf{43.339\ (\%)}$$

4. Ohm / Phase

$$= \frac{(\text{Measured voltage} \times 3)}{\text{Supply currnet}}$$

$$= \frac{2742.4 \times 3}{400.7}$$

$$= \mathbf{20.53\ (\Omega)}$$

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Zero sequence impedance

Serial No. 20120871TKE001

403 MVA base

1. Test circuit : Supply : LV Short : HV Open : TV

1) Tap No.	:	3 / 1L
2) Rated current	:	1683.9 (A)
3) Rated voltage	:	138175 (V)
4) Supply current	:	400.2 (A)
5) Measured voltage	:	408.6 (V)

2. Correction zero sequence impedance voltage (V)

$$= \text{Measured voltage} \times \frac{(\text{Rated current} \times 3)}{\text{Supply current}}$$

$$= 408.6 \times \frac{(1683.9 \times 3)}{400.2}$$

$$= \mathbf{5157.7\ (V)}$$

3. Zero sequence impedance (%)

$$= 300 \times \left(\frac{\text{Measured voltage}}{\text{Rated voltage} / \sqrt{3}}\right) \times \left(\frac{\text{Rated current}}{\text{Supply current}}\right)$$

$$= 300 \times \left(\frac{408.6}{138175 / \sqrt{3}}\right) \times \left(\frac{1683.9}{400.2}\right)$$

$$= \mathbf{6.465\ (\%)}$$

4. Ohm / Phase

$$= \frac{(\text{Measured voltage} \times 3)}{\text{Supply currnet}}$$

$$= \frac{408.6 \times 3}{400.2}$$

$$= \mathbf{3.06\ (\Omega)}$$

Date of Test : 2013. 02. 22	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Temperature rise test
(403MVA base)

Serial No.
20120871TKE001

	Winding temperature	Oil temperature	Max. ambient temp.	40 ℃
Guarantee value	65 K	65 K	Cooling method	ONAN
			Tap No. (HV/LV)	1 / 16L

The sum of the no-load loss and load loss at 85℃ were supplied to the transformer. One of its windings was being excited and another short circuited.
At that time the sum of total losses was 681.913kW for 15:1[hours:min.]
The oil temperature was measured via an oil pocket in the top cover. Then the transformer was excited with the rated current 642.3A for 1:0[hour(s):min.]. After the power was shut down, the resistance of the winding was measured and the winding temperature was evaluated from the increase of resistance.

Temperature at Total losses

1) Ambient temperature		23.80 ℃
2) Oil in the thermometer-pocket temperature		72.30 ℃
3) Oil radiator inlet temperature		66.10 ℃
4) Oil radiator outlet temperature		43.70 ℃
5) Difference between in and outlet	3) - 4)	22.40 K
6) Average oil temperature	2) - [5) × ½]	61.10 ℃
7) Average oil temperature-rise	6) - 1)	37.30 K
8) Maximum oil temperature-rise	2) - 1)	**48.50 K**

Temperature at Rated current

a) Ambient temperature		24.13 ℃
b) Oil in the thermometer-pocket temperature		70.20 ℃
c) Oil radiator inlet temperature		64.40 ℃
d) Oil radiator outlet temperature		43.70 ℃
e) Difference between in and outlet	c) - d)	20.70 K
f) Average oil temperature	b) - [e) × ½]	59.85 ℃

Temperature of winding

		HV(H2-H0)	LV(X2 -X3)
I) Average winding temperature(See cooling curve)		67.83 ℃	69.62 ℃
II) Average winding temperature-rise(Over oil)	I) - f)	7.98 K	9.77 K
III) Average oil temperature-rise(Over ambient)	6) - 1)	37.30 K	37.30 K
IV) Average winding temperature-rise(Over ambient)	II) + III)	**45.28 K**	**47.07 K**

Calculation of winding hottest spot temperature

Hot-spot temp. rise of winding = Max. top oil temp. rise + [Average winding temp. rise(over oil) × k'

☞ k' (HV/LV) =1.3 / 1.3 8) + [II) × k'] **58.87 K** **61.20 K**

Date of Test : 2013. 02. 23	Tested by : C. S. Ha

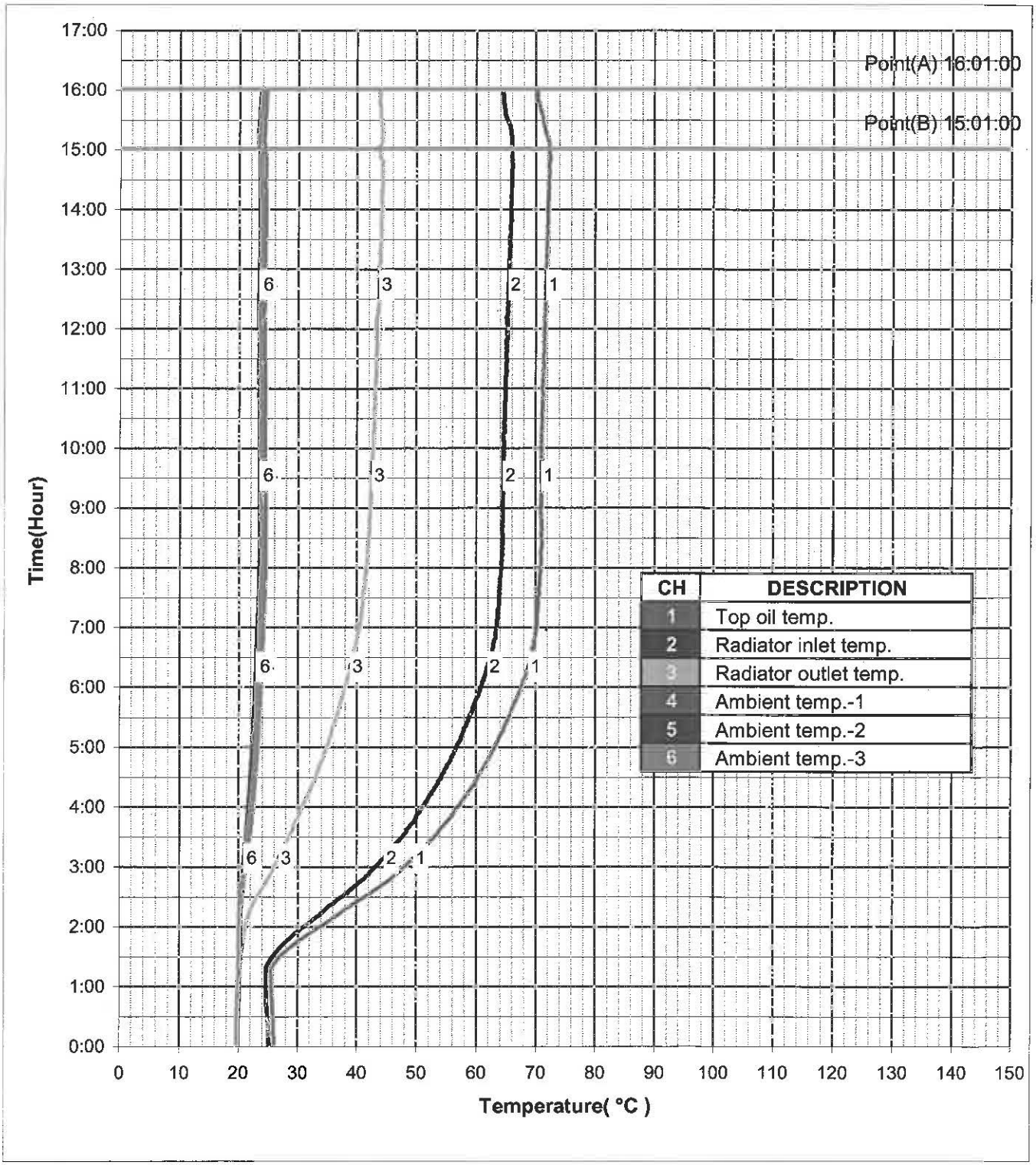
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Temperature Recorder Chart

Serial No
20120871TKE001

Test Object : 403MVA Base (ONAN), ***Test of Date : Feb-22-2013***

Channel	*CH1*	*CH2*	*CH3*	*CH4*	*CH5*	*CH6*
Point(A)	70.2	64.4	43.7	24.7	23.7	24.0
Point(B)	72.3	66.1	43.7	24.4	23.4	23.6



Date of Test : 2013.02.22	Tested by : J. C. Song

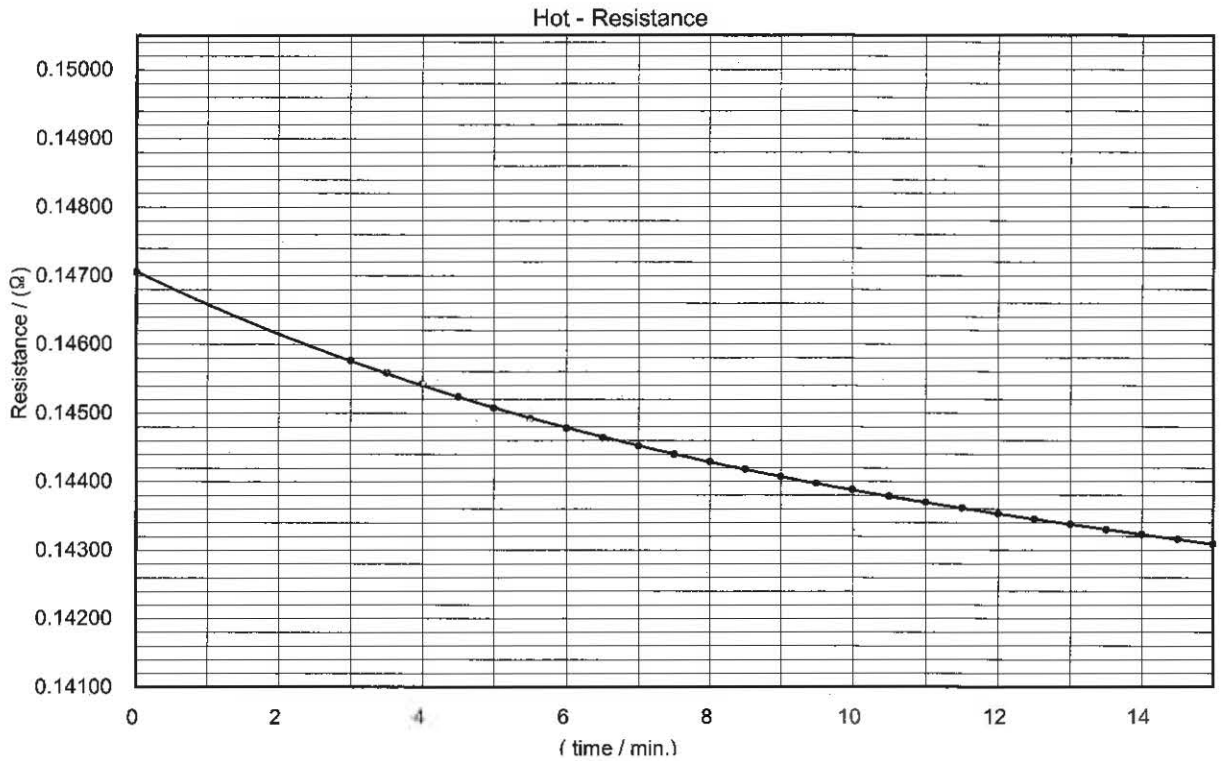
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Cooling Curve

(403MVA base, H2-X2)

Serial No. 20120871TKE001

After shutdown Resistance Value : 0.1470495 (Ω)



Resistance Measurement Terminal (H2-X2) time(min:sec)

time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)
00:00	-	06:30	0.1446358	13:00	0.1433714	-	-
00:30	-	07:00	0.1445143	13:30	0.1432946	-	-
01:00	-	07:30	0.1443944	14:00	0.1432231	-	-
01:30	-	08:00	0.1442868	14:30	0.1431527	-	-
02:00	-	08:30	0.1441759	15:00	0.1430832	-	-
02:30	-	09:00	0.1440690	-	-	-	-
03:00	0.1457573	09:30	0.1439701	-	-	-	-
03:30	0.1455831	10:00	0.1438761	-	-	-	-
04:00	0.1454208	10:30	0.1437824	-	-	-	-
04:30	0.1452310	11:00	0.1436963	-	-	-	-
05:00	0.1450685	11:30	0.1436090	-	-	-	-
05:30	0.1449115	12:00	0.1435258	-	-	-	-
06:00	0.1447712	12:30	0.1434470	-	-	-	-

*** Cold resistance = 0.1247599 (Ω) at 22.0 (℃)**

Winding resistance Measurement after Shutdown at Winding temperature

$$\frac{0.1470495}{0.1247599} \times (234.5 + 22.0) - 234.5 = 67.83$$

*** Average winding temperature at (℃) = 67.83**

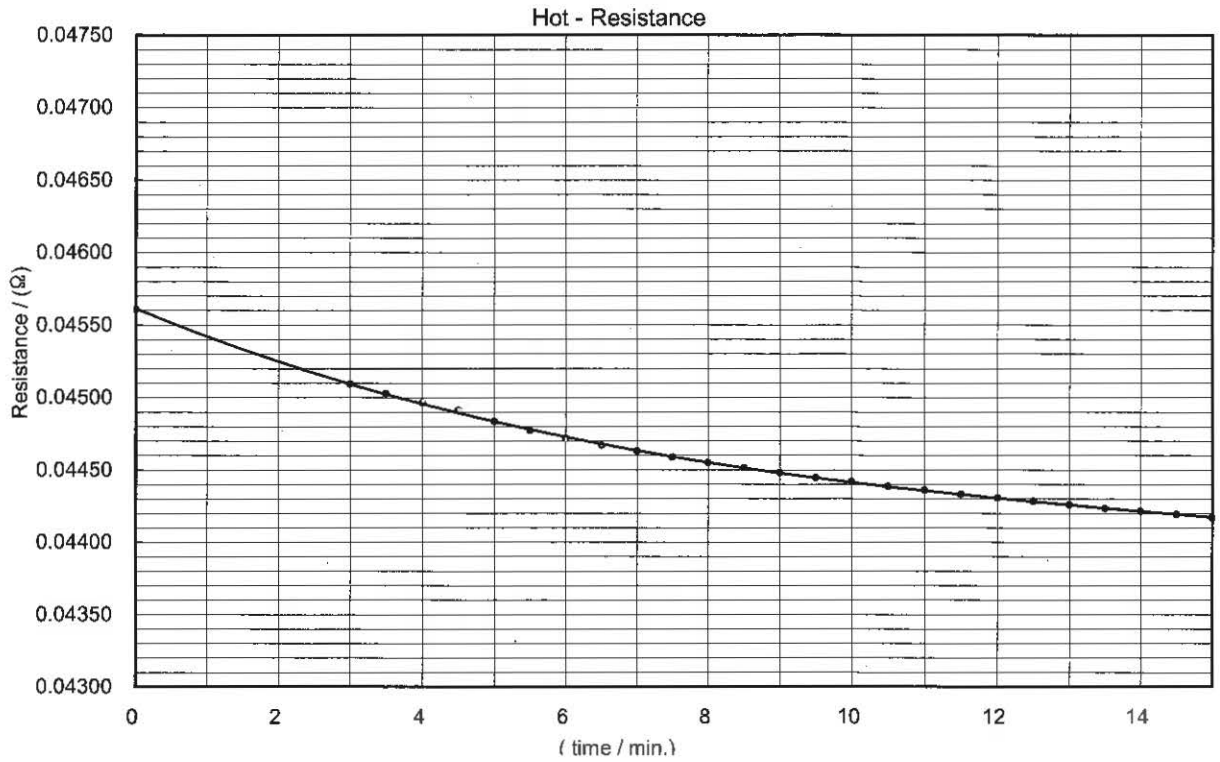
Date of Test : 2013. 02. 23	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Cooling Curve
(403MVA base, X2-H0X0)

Serial No.
20120871TKE001

After shutdown Resistance Value : 0.0456076 (Ω)



Resistance Measurement Terminal (X2-H0X0) time(min:sec)

time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)
00:00	-	06:30	0.0446687	13:00	0.0442563	-	-
00:30	-	07:00	0.0446265	13:30	0.0442328	-	-
01:00	-	07:30	0.0445859	14:00	0.0442127	-	-
01:30	-	08:00	0.0445482	14:30	0.0441908	-	-
02:00	-	08:30	0.0445130	15:00	0.0441691	-	-
02:30	-	09:00	0.0444771	-	-	-	-
03:00	0.0450908	09:30	0.0444448	-	-	-	-
03:30	0.0450245	10:00	0.0444146	-	-	-	-
04:00	0.0449639	10:30	0.0443850	-	-	-	-
04:30	0.0449090	11:00	0.0443577	-	-	-	-
05:00	0.0448326	11:30	0.0443303	-	-	-	-
05:30	0.0447699	12:00	0.0443043	-	-	-	-
06:00	0.0447167	12:30	0.0442804	-	-	-	-

*** Cold resistance = 0.0384668 (Ω) at 22.0 (℃)**

Winding resistance Measurement after Shutdown at Winding temperature

$$\frac{0.0456076}{0.0384668} \times (234.5 + 22.0) - 234.5 = 69.62$$

*** Average winding temperature at (℃) = 69.62**

Date of Test : 2013. 02. 23	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Temperature rise test
(672MVA base)

Serial No.
20120871TKE001

Guarantee value	Winding temperature	Oil temperature	Max. ambient temp.	40 ℃
	65 K	65 K	Cooling method	ONAF2
			Tap No. (HV/LV)	1 / 16L

The sum of the no-load loss and load loss at 85℃ were supplied to the transformer. One of its windings was being excited and another short circuited.
At that time the sum of total losses was 1641.206kW for 4:52[hours:min.]
The oil temperature was measured via an oil pocket in the top cover. Then the transformer was excited with the rated current 1071A for 1:0[hour(s):min.]. After the power was shut down, the resistance of the winding was measured and the winding temperature was evaluated from the increase of resistance.

Temperature at Total losses

1) Ambient temperature		27.83 ℃
2) Oil in the thermometer-pocket temperature		83.70 ℃
3) Oil radiator inlet temperature		78.50 ℃
4) Oil radiator outlet temperature		42.90 ℃
5) Difference between in and outlet	3) - 4)	35.60 K
6) Average oil temperature	2) - [5) × ½]	65.90 ℃
7) Average oil temperature-rise	6) - 1)	38.07 K
8) Maximum oil temperature-rise	2) - 1)	**55.87 K**

Temperature at Rated current

a) Ambient temperature		28.37 ℃
b) Oil in the thermometer-pocket temperature		82.70 ℃
c) Oil radiator inlet temperature		77.40 ℃
d) Oil radiator outlet temperature		42.90 ℃
e) Difference between in and outlet	c) - d)	34.50 K
f) Average oil temperature	b) - [e) × ½]	65.45 ℃

Temperature of winding

		HV(H2-H0)	LV(X2 -X3)
I) Average winding temperature(See cooling curve)		79.25 ℃	81.59 ℃
II) Average winding temperature-rise(Over oil)	I) - f)	13.80 K	16.14 K
III) Average oil temperature-rise(Over ambient)	6) - 1)	38.07 K	38.07 K
IV) Average winding temperature-rise(Over ambient)	II) + III)	**51.87 K**	**54.21 K**

Calculation of winding hottest spot temperature

Hot-spot temp. rise of winding = Max. top oil temp. rise + [Average winding temp. rise(over oil) × k'

☞ k' (HV/LV) =1.3 / 1.3 8) + [II) × k'] **73.81 K** **76.85 K**

Date of Test : 2013. 02. 23	Tested by : C. S. Ha

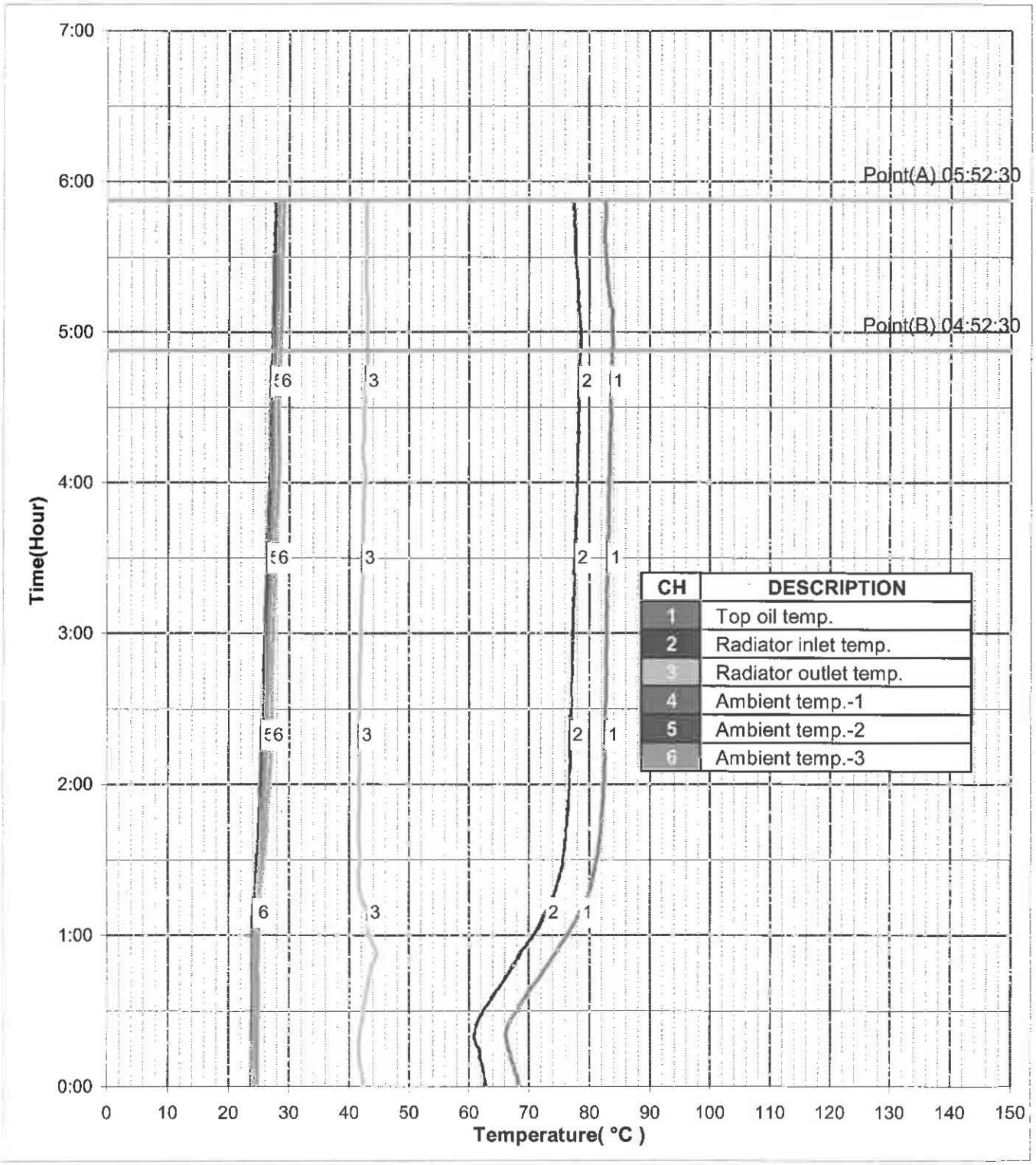
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Temperature Recorder Chart

Serial No
20120871TKE001

Test Object : 672MVA Base (ONAF2), ***Test of Date : Feb-22-2013***

Channel	*CH1*	*CH2*	*CH3*	*CH4*	*CH5*	*CH6*
Point(A)	82.7	77.4	42.9	28.3	27.7	29.1
Point(B)	83.7	78.5	42.9	27.7	27.2	28.6



Date of Test : 2013.02.22	Tested by : J. C. Song

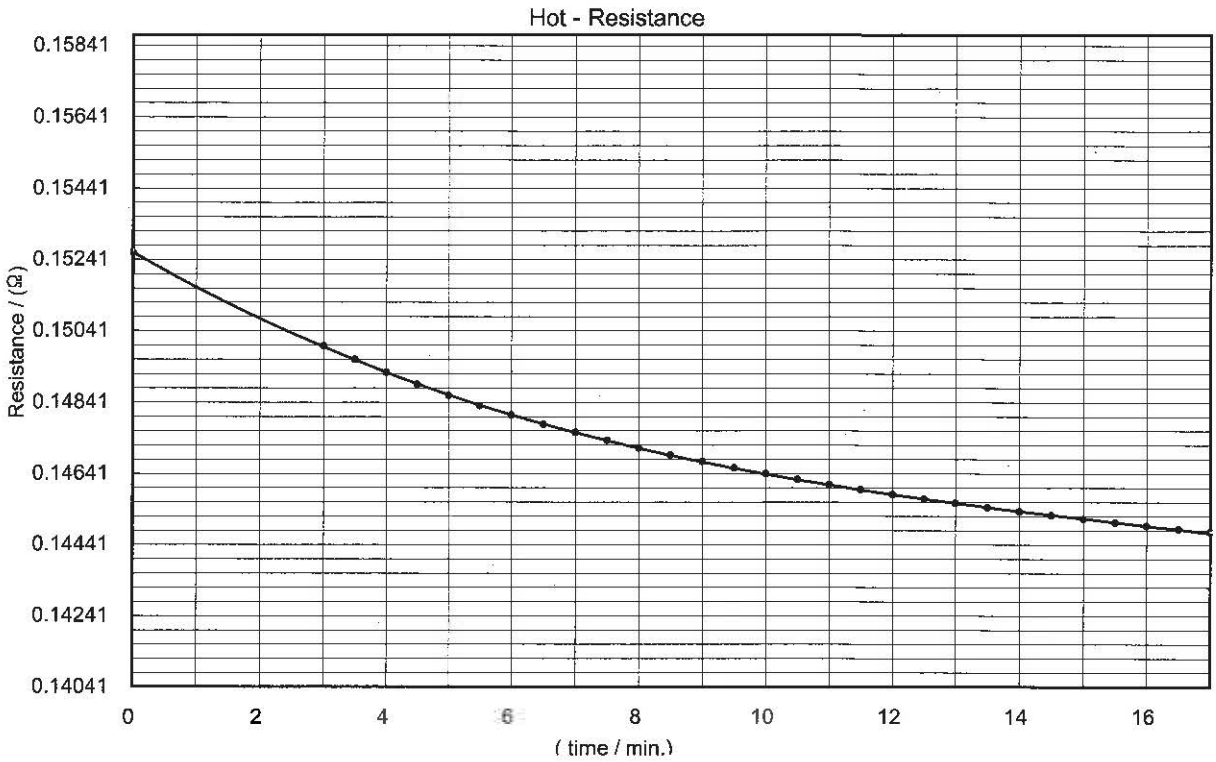
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Cooling Curve

(672MVA base, H2-X2)

Serial No. 20120871TKE001

After shutdown Resistance Value : 0.1526074 (Ω)



Resistance Measurement Terminal (H2-X2)

time(min:sec)

time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)
00:00	-	06:30	0.1477875	13:00	0.1455723	-	-
00:30	-	07:00	0.1475576	13:30	0.1454516	-	-
01:00	-	07:30	0.1473342	14:00	0.1453418	-	-
01:30	-	08:00	0.1471222	14:30	0.1452332	-	-
02:00	-	08:30	0.1469242	15:00	0.1451275	-	-
02:30	-	09:00	0.1467446	15:30	0.1450309	-	-
03:00	0.1499744	09:30	0.1465640	16:00	0.1449364	-	-
03:30	0.1496026	10:00	0.1464051	16:30	0.1448437	-	-
04:00	0.1492420	10:30	0.1462430	17:00	0.1447566	-	-
04:30	0.1489057	11:00	0.1460942	-	-	-	-
05:00	0.1485925	11:30	0.1459530	-	-	-	-
05:30	0.1483056	12:00	0.1458192	-	-	-	-
06:00	0.1480415	12:30	0.1456898	-	-	-	-

*** Cold resistance = 0.1247599 (Ω) at 22.0 (℃)**

Winding resistance Measurement after Shutdown at Winding temperature

$$\frac{0.1526074}{0.1247599} \times (234.5 + 22.0) - 234.5 = 79.25$$

*** Average winding temperature at (℃) = 79.25**

Date of Test : 2013. 02. 23	Tested by : C. S. Ha

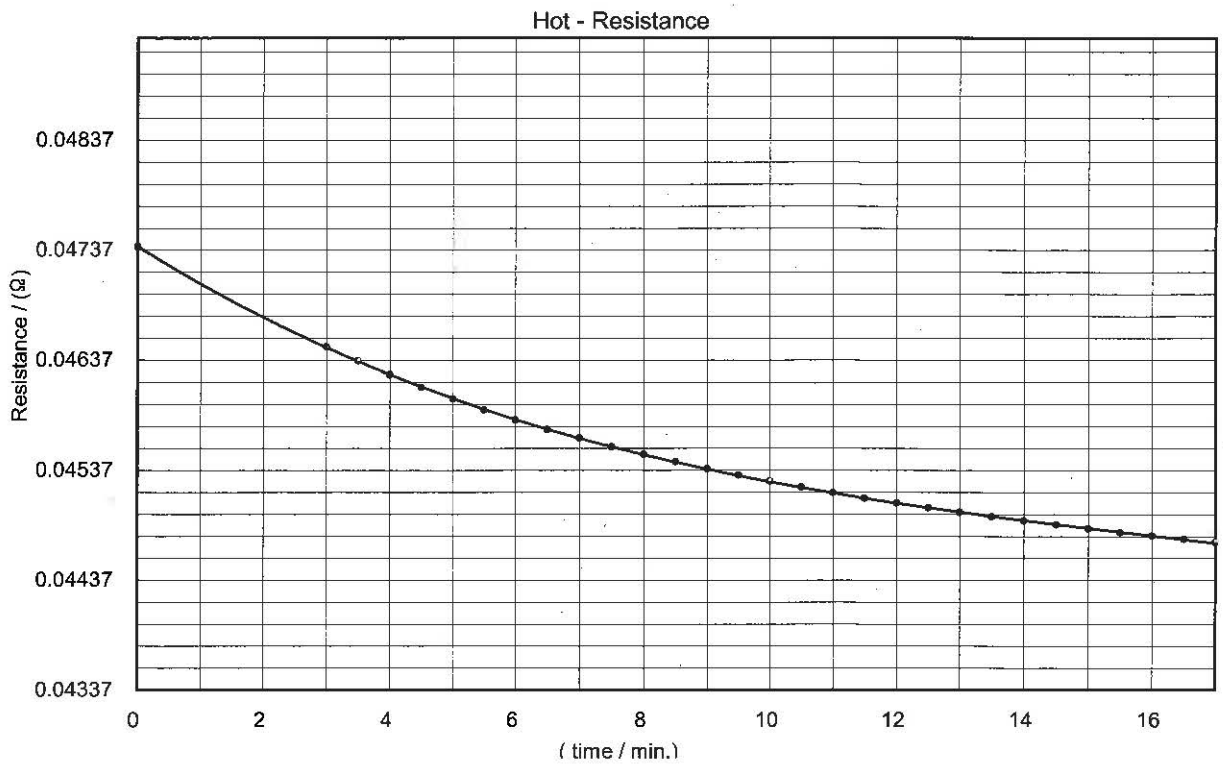
HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Cooling Curve

(672MVA base, X2-H0X0)

Serial No.
20120871TKE001

After shutdown Resistance Value : 0.0474035 (Ω)



Resistance Measurement Terminal (X2-H0X0)

time(min:sec)

time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)
00:00	-	06:30	0.0457434	13:00	0.0449897	-	-
00:30	-	07:00	0.0456640	13:30	0.0449497	-	-
01:00	-	07:30	0.0455877	14:00	0.0449121	-	-
01:30	-	08:00	0.0455157	14:30	0.0448756	-	-
02:00	-	08:30	0.0454486	15:00	0.0448403	-	-
02:30	-	09:00	0.0453864	15:30	0.0448073	-	-
03:00	0.0464948	09:30	0.0453267	16:00	0.0447762	-	-
03:30	0.0463656	10:00	0.0452720	16:30	0.0447448	-	-
04:00	0.0462419	10:30	0.0452180	17:00	0.0447149	-	-
04:30	0.0461264	11:00	0.0451666	-	-	-	-
05:00	0.0460193	11:30	0.0451187	-	-	-	-
05:30	0.0459195	12:00	0.0450740	-	-	-	-
06:00	0.0458294	12:30	0.0450298	-	-	-	-

*** Cold resistance = 0.0384668 (Ω) at 22.0 (℃)**

Winding resistance Measurement after Shutdown at Winding temperature

$$\frac{0.0474035}{0.0384668} \times (234.5 + 22.0) - 234.5 = 81.59$$

*** Average winding temperature at (℃) = 81.59**

Date of Test : 2013. 02. 23	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Temperature rise test
(5MVA base)

Serial No.
20120871TKE001

	Winding temperature	Oil temperature	Max. ambient temp.	40 ℃
Guarantee value	65 K	65 K	Cooling method	ONAF2
			Tap No. (HV/LV)	1/16L

The sum of the no-load loss and load loss at 85℃ were supplied to the transformer. One of its windings was being excited and another short circuited.
At that time the sum of total losses was 1641.206 kW for 4:52 [hours:min.]
The oil temperature was measured via an oil pocket in the top cover. Then the transformer was excited with the rated current 8.0 A for 1:0 [hour:min.]. After the power was shut down, the resistance of the winding was measured and the winding temperature was evaluated from the increase of resistance.

Temperature at Total losses

1) Ambient temperature		27.83	℃
2) Oil in the thermometer-pocket temperature		83.70	℃
3) Oil radiator inlet temperature		78.50	℃
4) Oil radiator outlet temperature		42.90	℃
5) Difference between in and outlet	3) - 4)	35.60	K
6) Average oil temperature	2) - [5) × ½]	65.90	℃
7) Average oil temperature-rise	6) - 1)	38.07	K
8) Maximum oil temperature-rise	2) - 1)	**55.87**	**K**

Temperature at Rated current

a) Ambient temperature		28.00	℃
b) Oil in the thermometer-pocket temperature		60.70	℃
c) Oil radiator inlet temperature		58.30	℃
d) Oil radiator outlet temperature		34.60	℃
e) Difference between in and outlet	c) - d)	23.70	K
f) Average oil temperature	b) - [e) × ½]	48.85	℃

Temperature of winding

		TV(Y2-Y3)	
I) Average winding temperature(See cooling curve)		63.40	℃
II) Average winding temperature-rise(Over oil)	I) - f)	14.55	K
III) Average oil temperature-rise(Over ambient)	6) - 1)	38.07	K
IV) Average winding temperature-rise(Over ambient)	II) + III)	**52.62**	**K**

Calculation of winding hottest spot temperature

Hot-spot temp. rise of winding = Max. top oil temp. rise + [Average winding temp. rise(over oil) × k'

☞ k' (TV) = 1.3 8) + [II) × k'] **74.79 K**

Date of Test : 2013. 02. 23	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

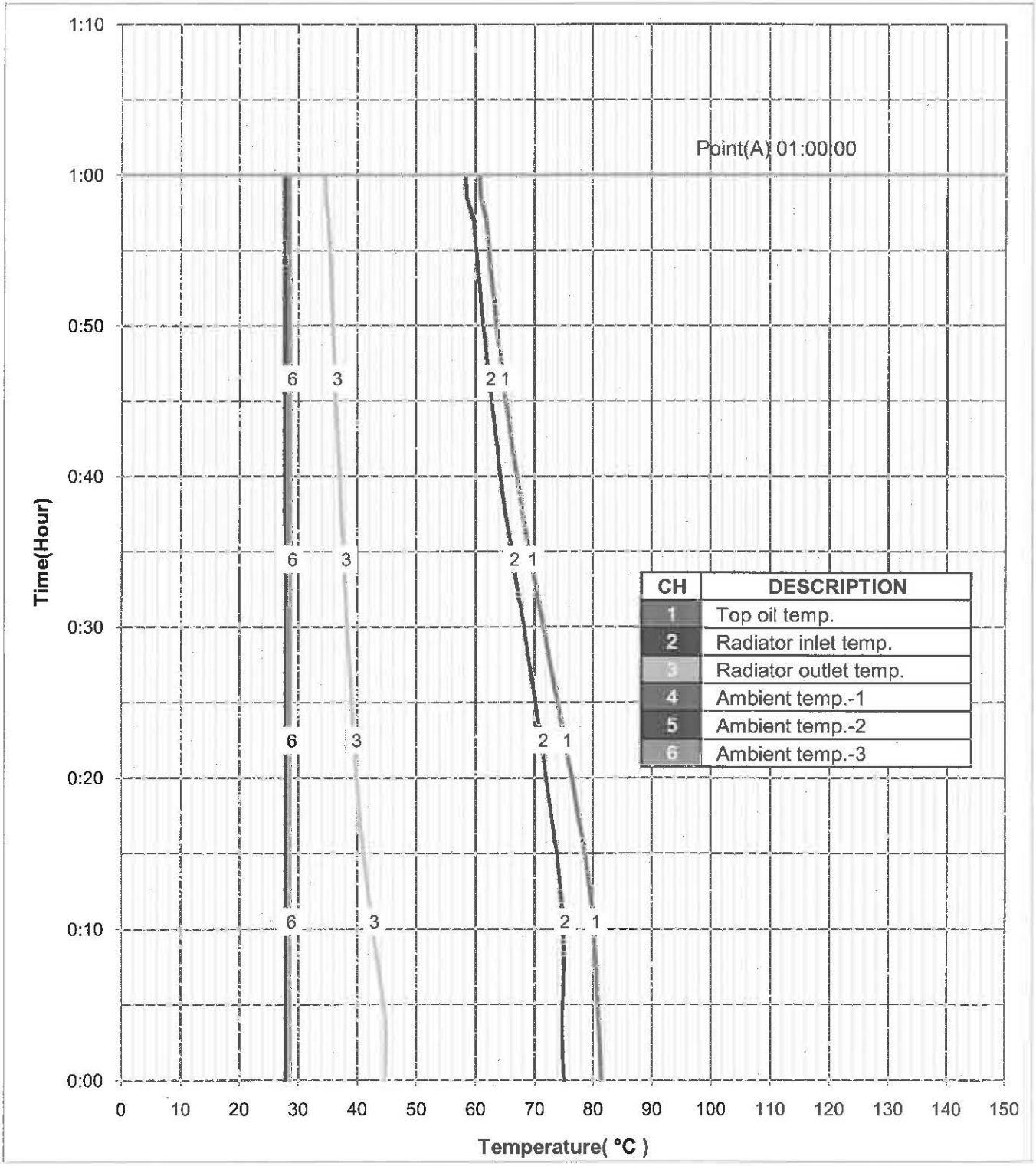
Temperature Recorder Chart

Serial No
20120871TKE001

Test Object : 5MVA Base (ONAF2),HV-TV

Test of Date : Feb-23-2013

Channel	*CH1*	*CH2*	*CH3*	*CH4*	*CH5*	*CH6*
Point(A)	60.7	58.3	34.6	27.8	27.7	28.5



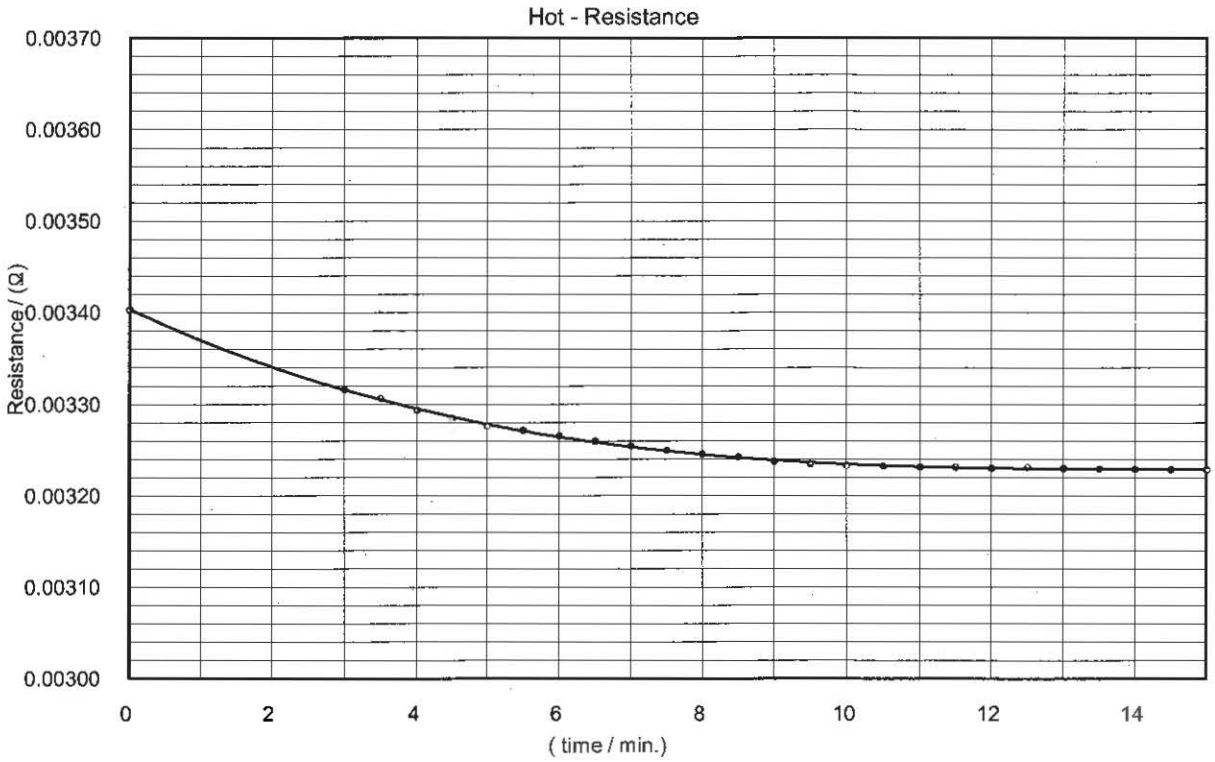
Date of Test : 2013.02.23	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Winding Resistance Cooling Curve
(5MVA base, Y2-Y3)

Serial No.
20120871TKE001

After shutdown Resistance Value : 0.0034033 (Ω)



Resistance Measurement Terminal (Y2-Y3) time(min:sec)

time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)	time	Resistance(Ω)
00:00	-	06:30	0.0032597	13:00	0.0032301	-	-
00:30	-	07:00	0.0032547	13:30	0.0032298	-	-
01:00	-	07:30	0.0032497	14:00	0.0032291	-	-
01:30	-	08:00	0.0032457	14:30	0.0032289	-	-
02:00	-	08:30	0.0032427	15:00	0.0032286	-	-
02:30	-	09:00	0.0032377	-	-	-	-
03:00	0.0033167	09:30	0.0032348	-	-	-	-
03:30	0.0033067	10:00	0.0032333	-	-	-	-
04:00	0.0032937	10:30	0.0032326	-	-	-	-
04:30	0.0032847	11:00	0.0032316	-	-	-	-
05:00	0.0032767	11:30	0.0032315	-	-	-	-
05:30	0.0032717	12:00	0.0032302	-	-	-	-
06:00	0.0032657	12:30	0.0032312	-	-	-	-

*** Cold resistance = 0.0029303 (Ω) at 22.0 (℃)**

Winding resistance Measurement after Shutdown at Winding temperature

$$\frac{0.0034033}{0.0029303} \times (234.5 + 22.0) - 234.5 = 63.40$$

*** Average winding temperature at (℃) = 63.40**

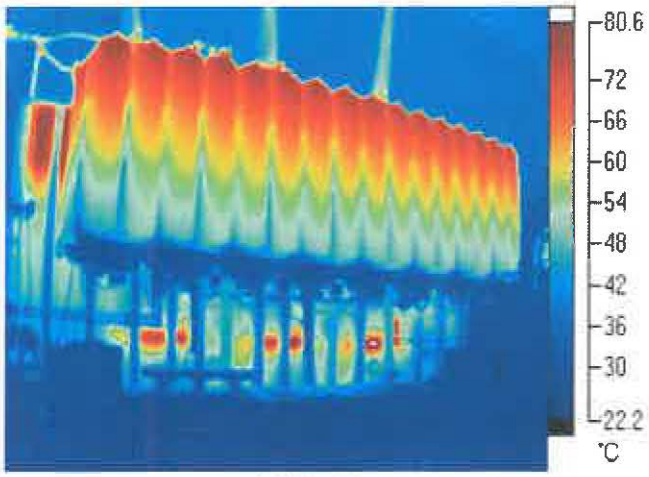
Date of Test : 2013. 02. 23	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

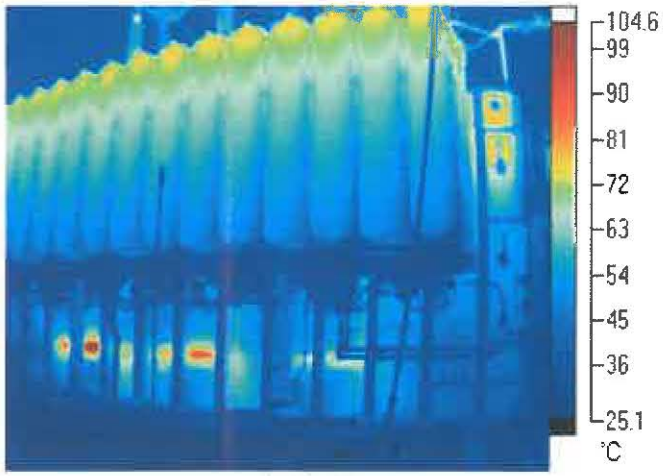
Thermal scan at during Heat-run Test

Serial No.
20120871TKE001

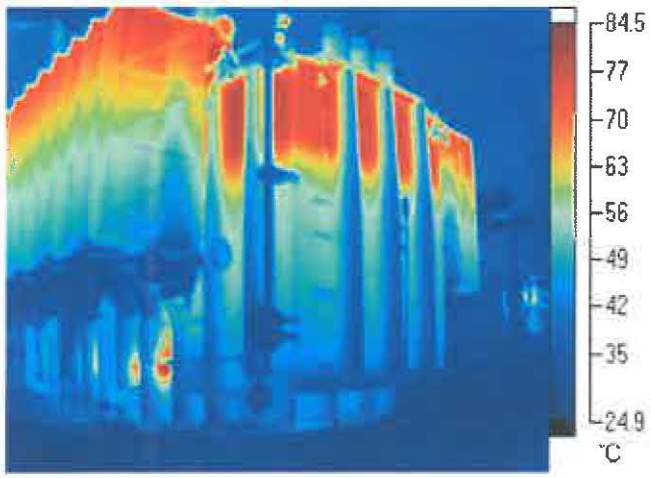
Test condition : ONAF2 Rating 672MVA Base (Ambient Temp : 27℃)



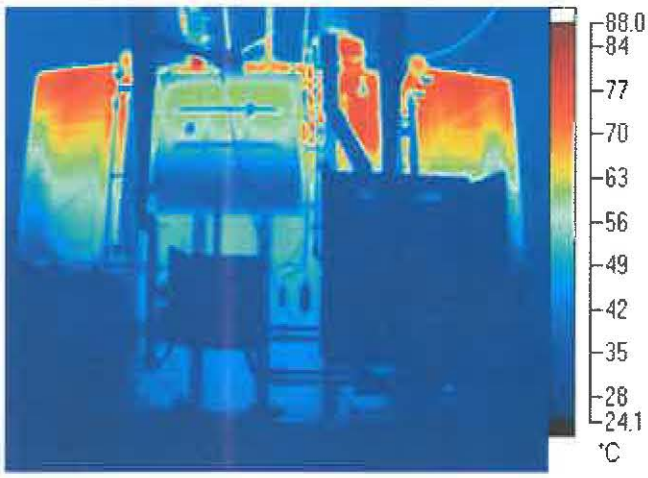
HV side



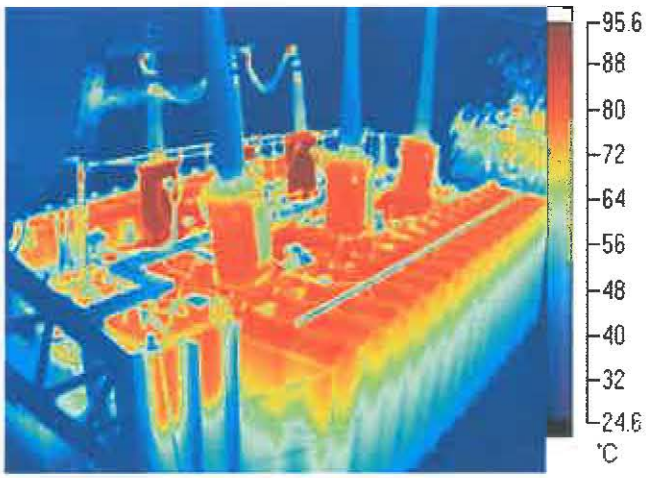
LV side



TV side



PNL side



Top View

Date of Test : 2013. 02. 23	Tested by : B. Y. Cheon

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Fiberoptic temperature (WTS monitor)

Serial No. 20120871TKE001

Time	Ch1-H1	Ch2-H2	Ch3-H3	Ch4-X1	Ch5-X2	Ch6-X3	Ch7-H2	Ch8-X2	Remark
02.22 18:00	30.2	29.8	30.1	27.8	29.3	29.7	28.8	28.7	ONAN rating 403MVA base (Total loss)
19:00	44.2	43.9	43.5	41.2	39.7	38.7	37.7	40.3	
20:00	63.8	63.8	63.8	60.2	54.7	51.7	48.1	55.7	
21:00	74.6	75	73.8	71.5	69.3	68.8	62.3	69.3	
22:00	80.8	80.9	79.7	77.5	77	78	69.8	78.1	
23:00	84.7	84.7	83.3	81	81.1	82.1	73.9	79.7	
0:00	87.7	87.7	86.2	83.8	84.2	85.1	77.6	82.6	
1:00	86.5	86.4	84.8	82.9	83.7	85.1	78.4	82	
2:00	86.3	86.3	84.7	82.9	83.6	84.6	78.5	82	
3:00	86	86.1	84.5	82.6	83.2	83.6	77.2	81.3	
4:00	85.9	86	84.3	82.5	83	82.9	77.8	81.4	
5:00	86.1	86.2	84.5	82.9	83.1	83.4	77.8	81.3	
6:00	86.5	86.5	84.8	83	83.2	83.6	77.9	81.9	
7:00	86.9	86.9	85.4	83.4	83.4	83.7	78.5	82.2	
8:00	87.2	87.2	85.7	83.6	83.5	84.2	78.7	82.5	
8:40	83.5	83.5	82	80.5	80.7	81.2	76.4	79.6	
9:40	70.9	71.1	70.4	69.7	70.9	68.1	68.1	69.8	Rated current
10:10	67.2	67.2	66.9	66	67.2	66.9	64.8	66.5	ONAF2 rating 672MVA base (Total loss)
11:00	108.8	106.7	106	101.7	99	97.3	89	98.4	
12:00	109.4	109.4	106.6	102.4	97.2	95.2	83.5	96.2	
13:00	109.1	109.1	106.3	102.1	96.1	93.6	81.2	94.6	
14:00	109.6	109.5	106.7	102.7	96.8	94.7	83	96	
15:00	107.8	107.7	105.3	101.2	95.8	93.6	83.1	94.9	
16:00	107	106.8	104.2	100.5	94.8	92.4	81	93.6	Rated current

※ Remark : Fiberoptic sensor position

1. HV side probe #1,2,3,7
2. LV side probe #4,5,6,8

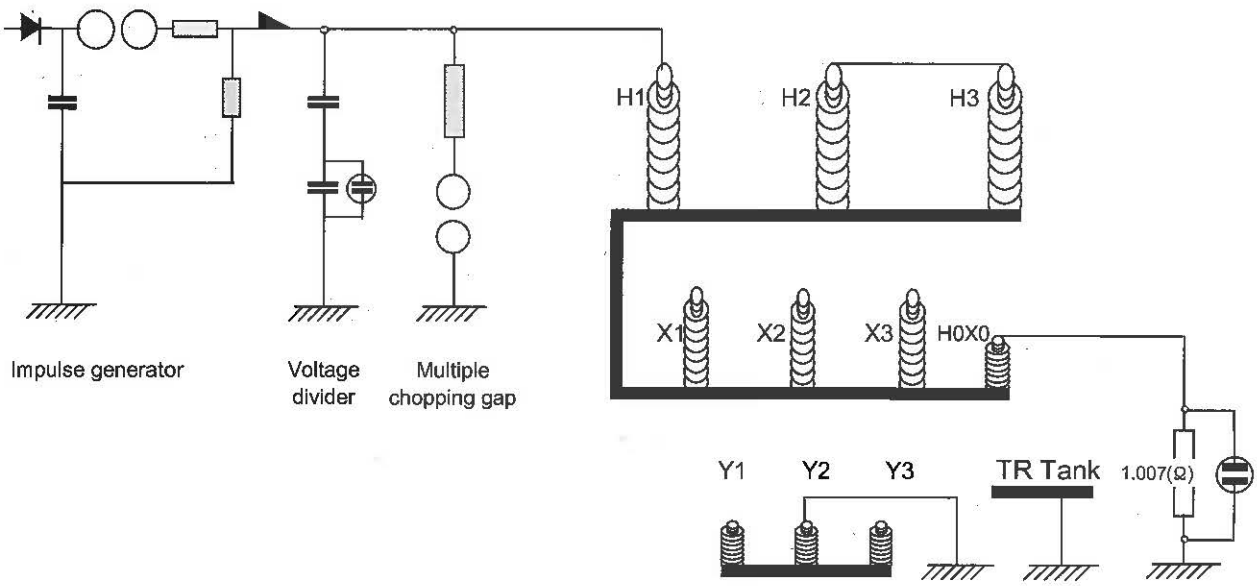
Date of Test : 2013. 02. 22~ 23 | Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Switching impulse voltage withstand test

Serial No. 20120871TKE001

Switching impulse voltage test with HV winding



※ Tp means peak voltage time.

※ Td means 90% voltage time.

※ To means drop the zero point time.

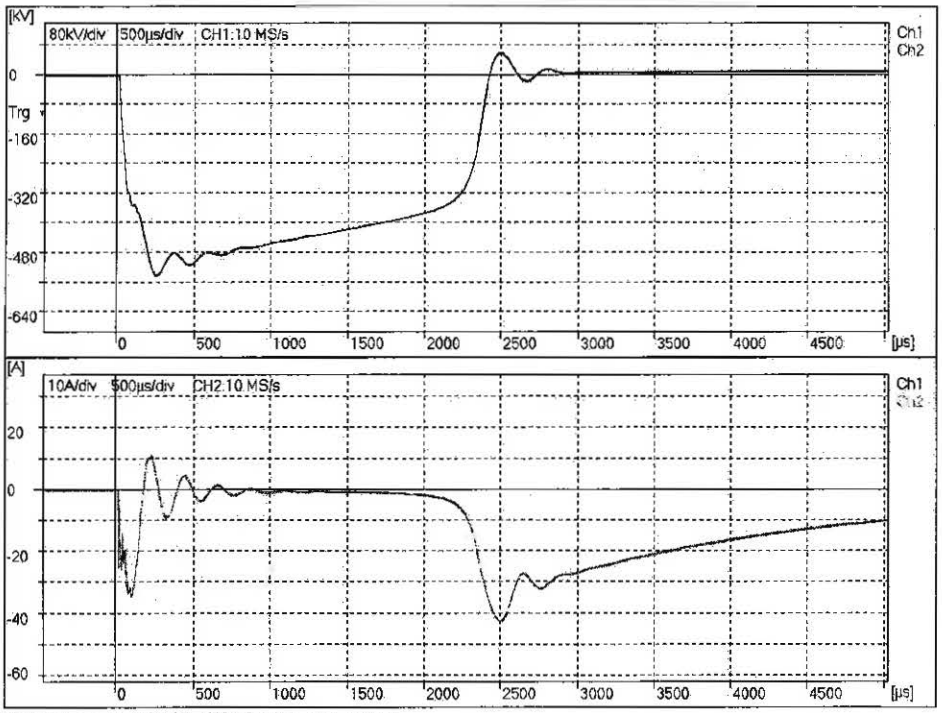
Date of Test : 2013. 02. 24	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Switching Impulses Test Report

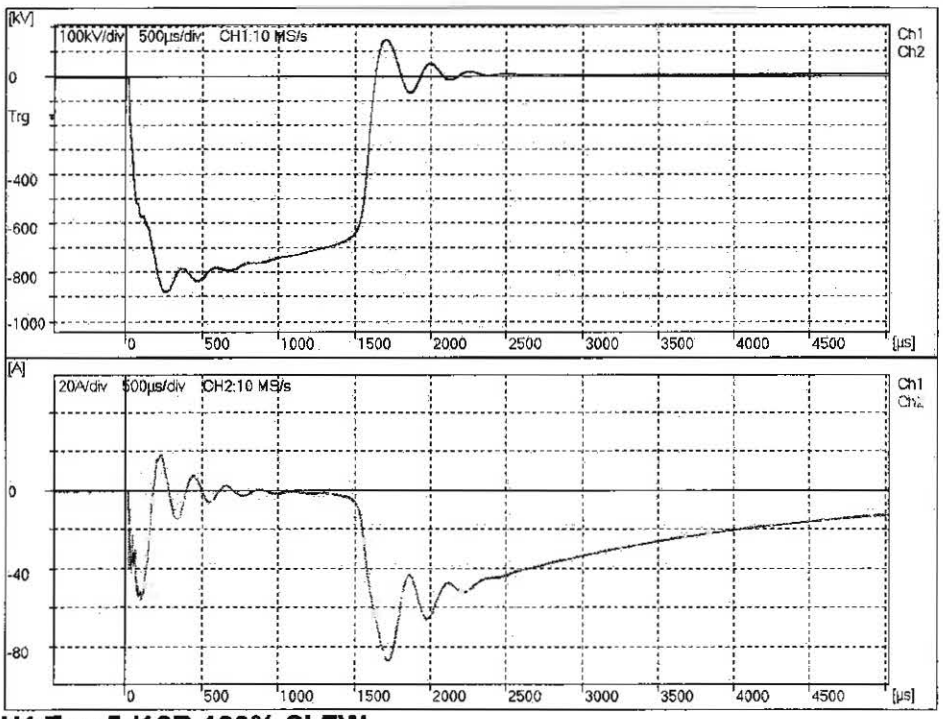
Serial No.
20120871TKE001

SI-Switching Impulse Pictures



No: 1
Ch1: H1
Up = -536.5 kV
Tp = 263.6 µs
Td = 365.7 µs
Tz = 2427 µs
Ch2: H0X0
+Ip = 11.20 A
-Ip = -42.78 A

H1 Tap 5 /16R 62.07% SI RW



No: 2
Ch1: H1
Up = -872.8 kV
Tp = 264.2 µs
Td = 481.4 µs
Tz = 1639 µs
Ch2: H0X0
+Ip = 18.32 A
-Ip = -87.36 A

H1 Tap 5 /16R 100% SI FW

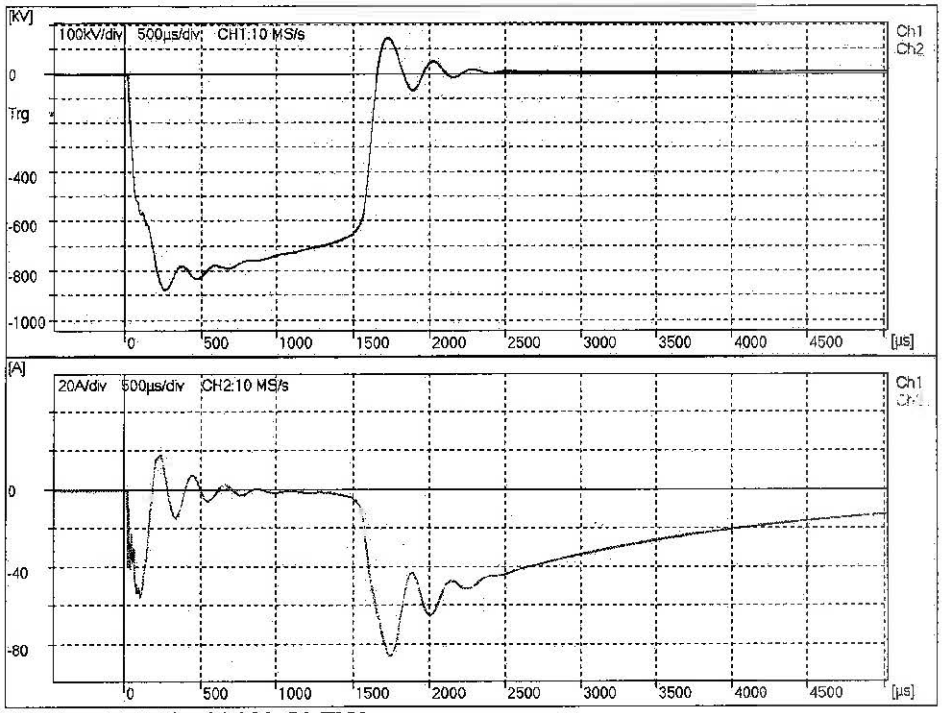
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Switching Impulses Test Report

Serial No.
20120871TKE001

SI-Switching Impulse Pictures



No: 3
Ch1: H1
Up = -868.8 kV
Tp = 264.1 µs
Td = 488.5 µs
Tz = 1665 µs
Ch2: H0X0
+Ip = 18.26 A
-Ip = -86.59 A

H1 Tap 5 /16R 100% SI FW

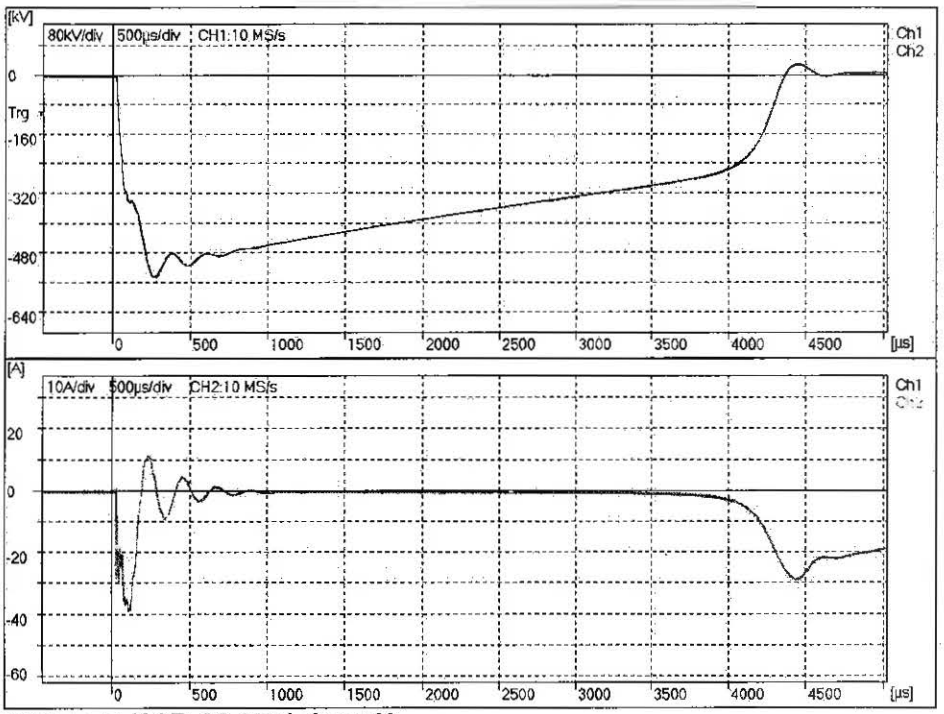
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Switching Impulses Test Report

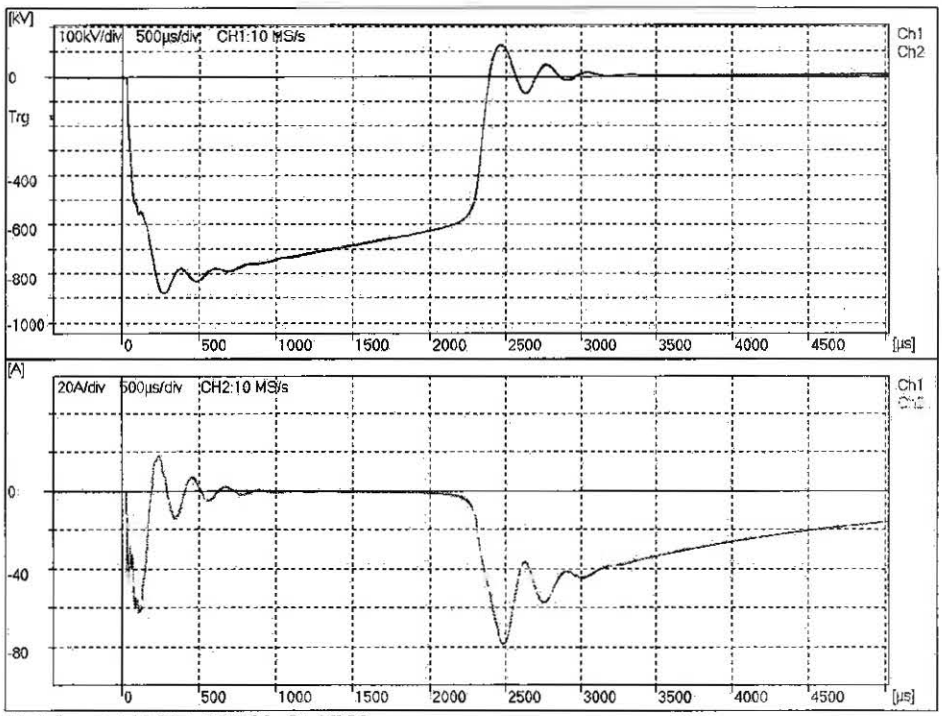
Serial No.
20120871TKE001

SI-Switching Impulse Pictures



No: 1
Ch1: H2
Up = -539.9 kV
Tp = 268.4 µs
Td = 333.8 µs
Tz = 4370 µs
Ch2: H0X0
+Ip = 11.70 A
-Ip = -38.95 A

H2 Tap 5 /16R 62.07% SI RW



No: 2
Ch1: H2
Up = -869.6 kV
Tp = 269.0 µs
Td = 358.7 µs
Tz = 2393 µs
Ch2: H0X0
+Ip = 18.49 A
-Ip = -78.33 A

H2 Tap 5 /16R 100% SI FW

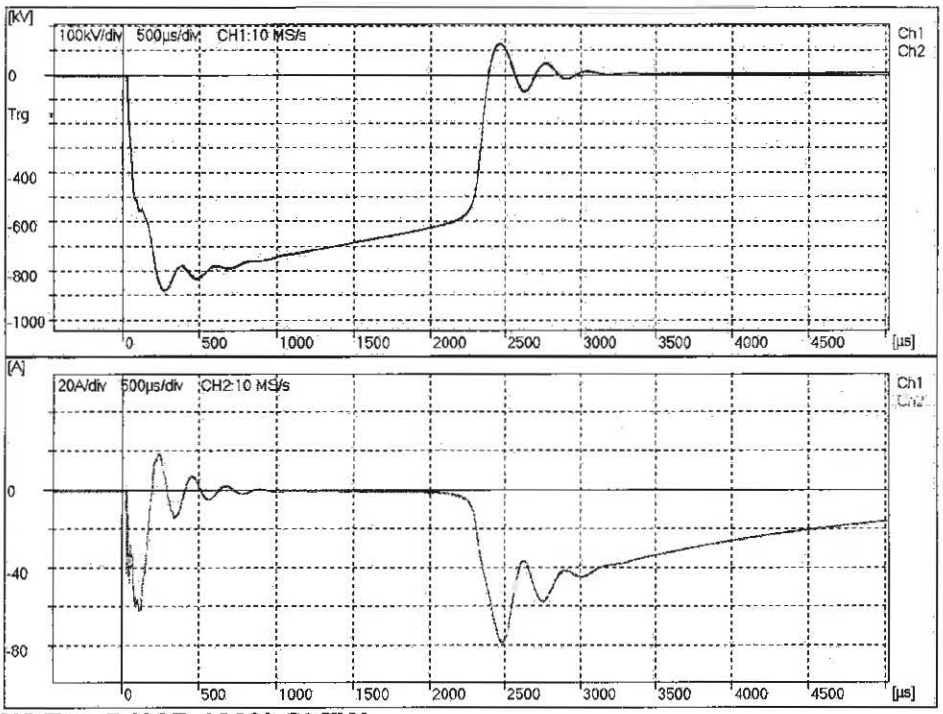
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO. LTD.

Switching Impulses Test Report

Serial No.
20120871TKE001

SI-Switching Impulse Pictures



No: 3
Ch1: H2
Up = -870.4 kV
Tp = 268.9 µs
Td = 359.6 µs
Tz = 2391 µs
Ch2: H0X0
+Ip = 18.65 A
-Ip = -78.50 A

H2 Tap 5 /16R 100% SI FW

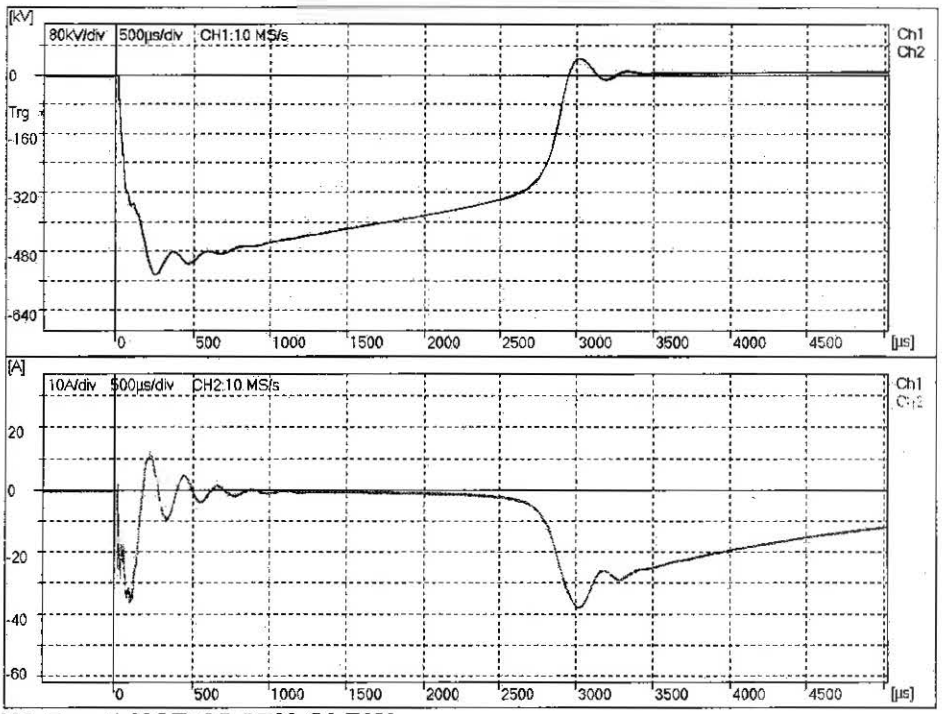
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Switching Impulses Test Report

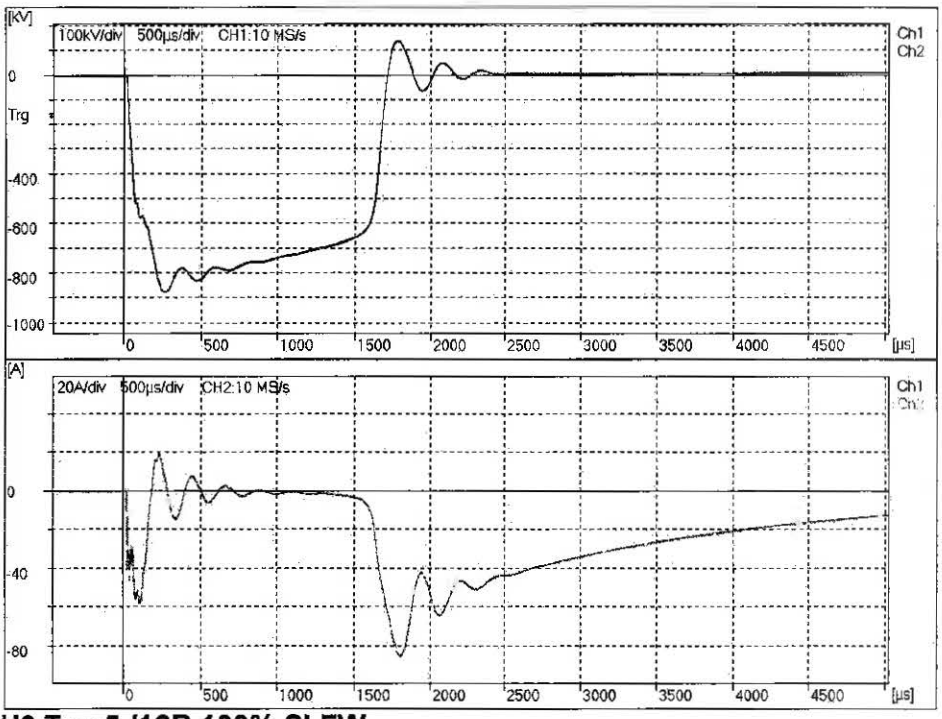
Serial No.
20120871TKE001

SI-Switching Impulse Pictures



No: 1
Ch1: H3
Up = -537.6 kV
Tp = 263.6 µs
Td = 335.4 µs
Tz = 2951 µs
Ch2: H0X0
+Ip = 12.09 A
-Ip = -37.96 A

H3 Tap 5 /16R 62.07% SI RW



No: 2
Ch1: H3
Up = -870.0 kV
Tp = 264.3 µs
Td = 350.6 µs
Tz = 1720 µs
Ch2: H0X0
+Ip = 19.43 A
-Ip = -85.59 A

H3 Tap 5 /16R 100% SI FW

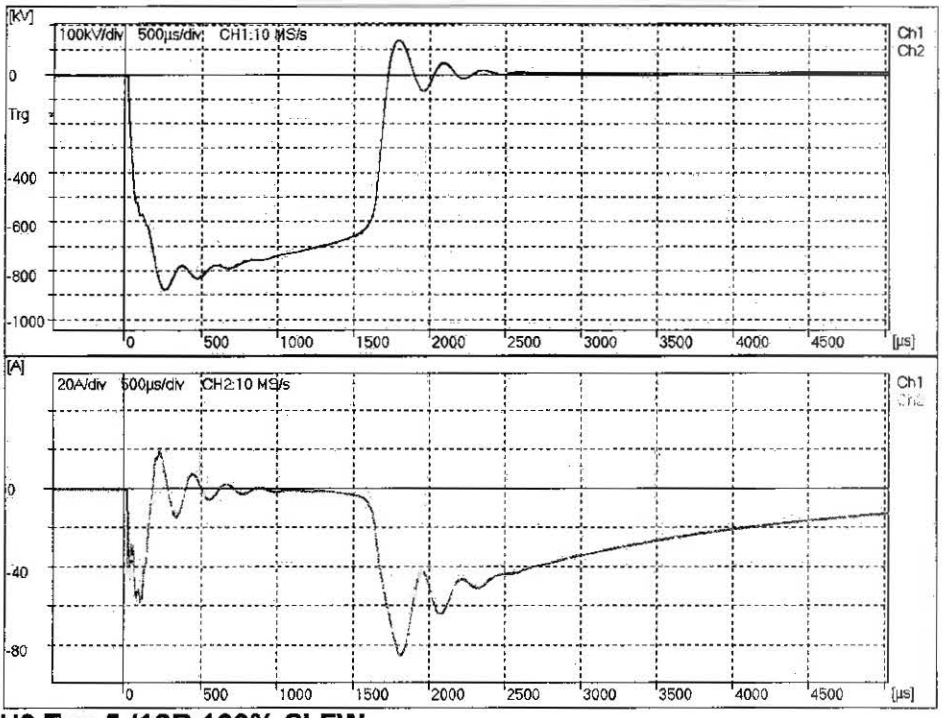
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO., LTD.

Switching Impulses Test Report

Serial No.
20120871TKE001

SI-Switching Impulse Pictures



No: 3
Ch1: H3
Up = -869.9 kV
Tp = 264.2 µs
Td = 351.3 µs
Tz = 1731 µs
Ch2: H0X0
+Ip = 19.48 A
-Ip = -85.42 A

H3 Tap 5 /16R 100% SI FW

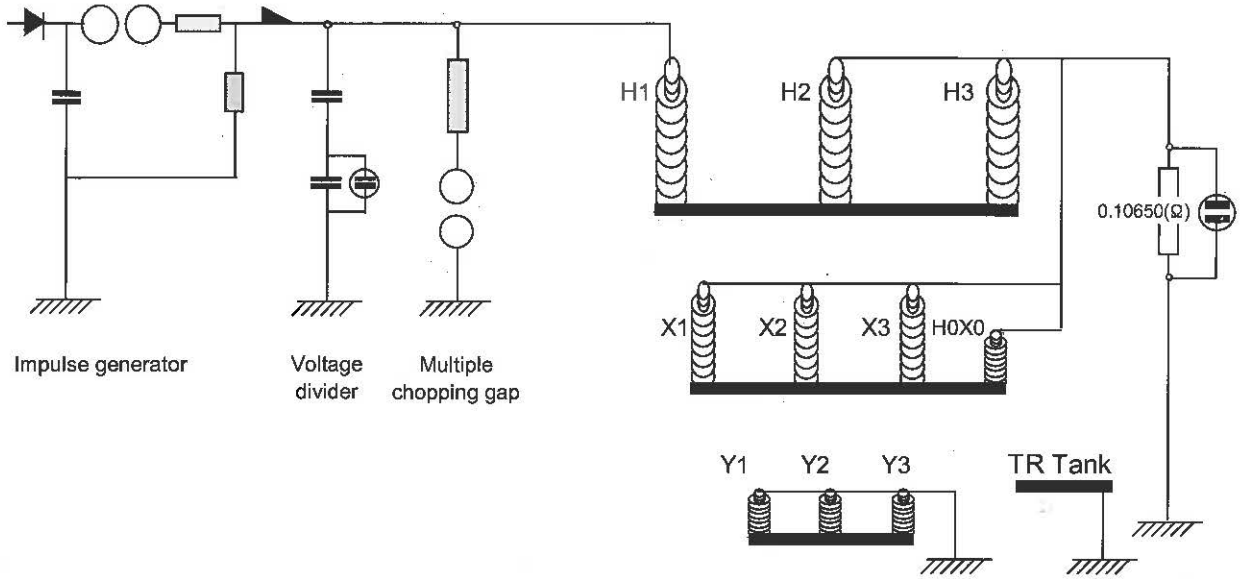
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning impulse voltage withstand test

Serial No. 20120671TKE001

Lightning impulse voltage test with HV winding



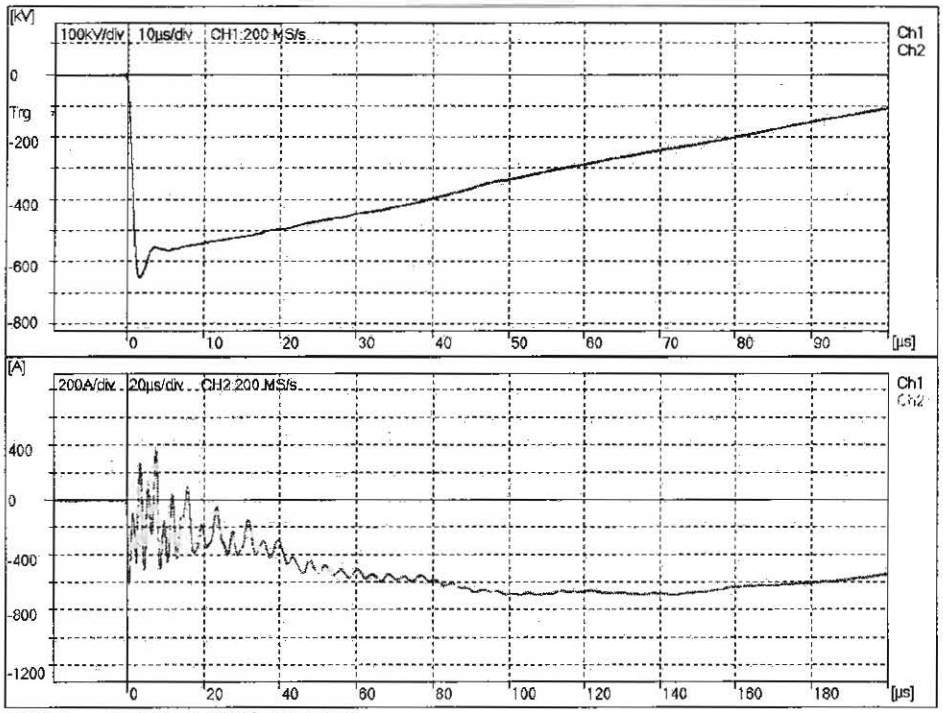
Date of Test : 2013. 02. 24	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

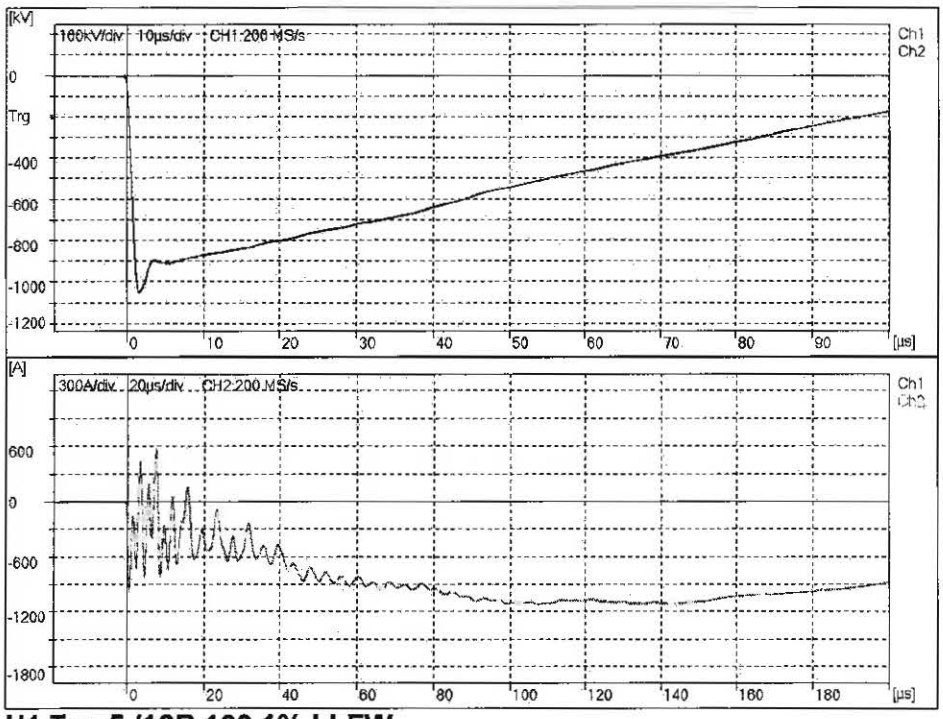
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: H1
Up = -650.5 kV
T1 = 1.242 μs
T2 = 51.94 μs
Ch2:
H2+H3+LV+H0X0
+Ip = 362.3 A
-Ip = -695.4 A

H1 Tap 5 /16R 62% LI RW



No = 2
Ch1: H1
Up = -1049 kV
T1 = 1.255 μs
T2 = 52.17 μs
Ch2:
H2+H3+LV+H0X0
+Ip = 580.7 A
-Ip = -1120 A

H1 Tap 5 /16R 100.1% LI FW

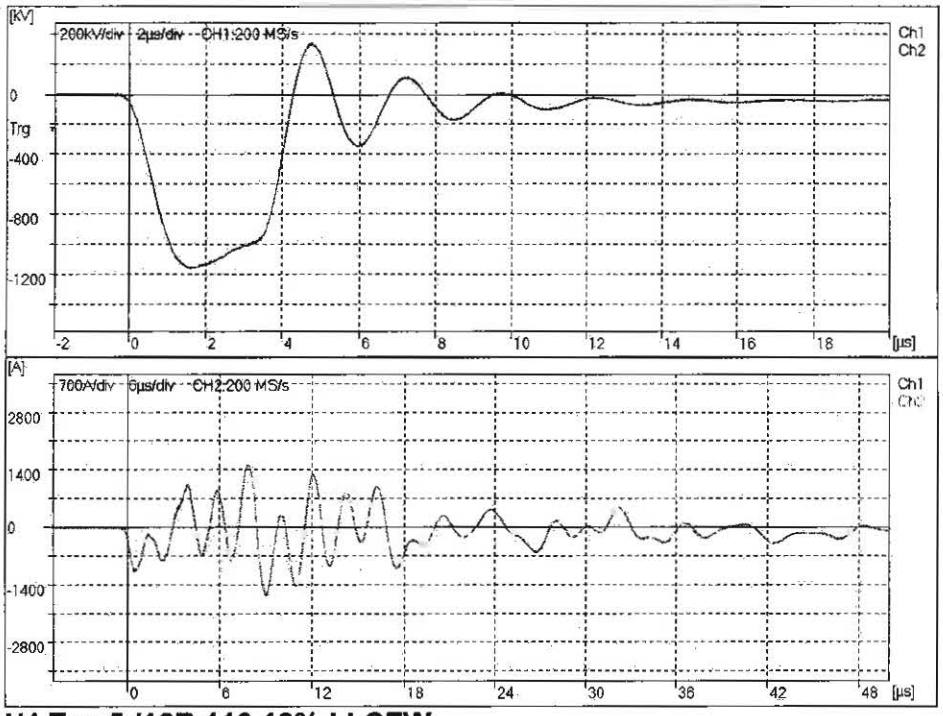
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO. LTD.

Lightning Impulses Test Report

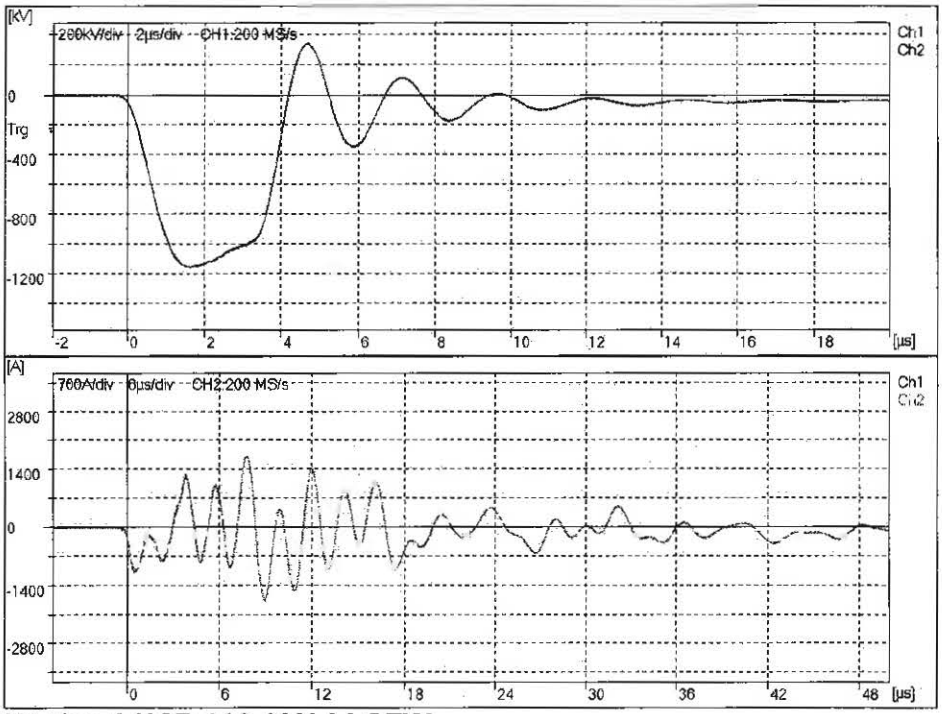
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: H1
Up = -1157 kV
T1 = 1.255 μs
Tc = 3.392 μs
Ch2:
H2+H3+LV+H0X0
+Ip = 1544 A
-Ip = -1665 A

H1 Tap 5 /16R 110.19% LI CFW



No = 4
Ch1: H1
Up = -1155 kV
T1 = 1.255 μs
Tc = 3.260 μs
Ch2:
H2+H3+LV+H0X0
+Ip = 1720 A
-Ip = -1766 A

H1 Tap 5 /16R 110.19% LI CFW

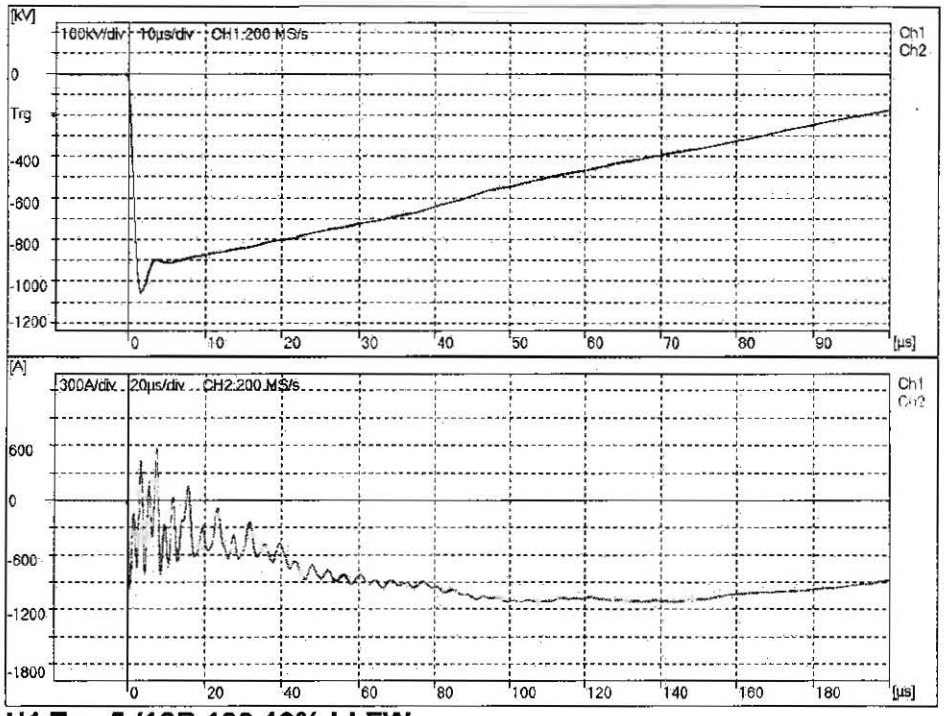
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

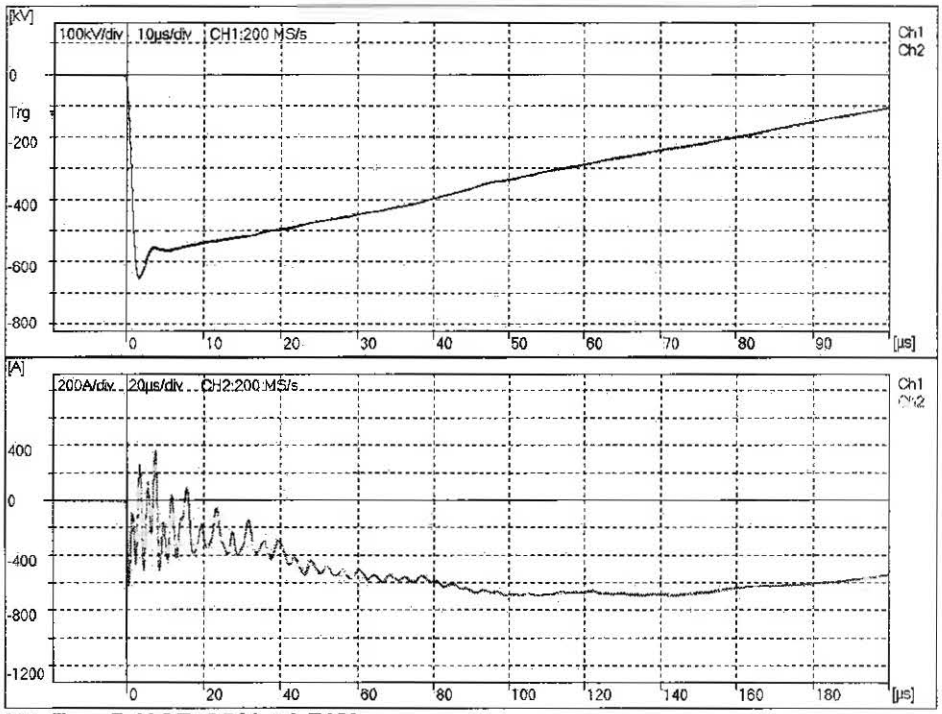
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: H1
Up = -1050 kV
T1 = 1.253 μs
T2 = 52.20 μs
Ch2:
H2+H3+LV+H0X0
+Ip = 581.7 A
-Ip = -1120 A

H1 Tap 5 /16R 100.19% LI FW

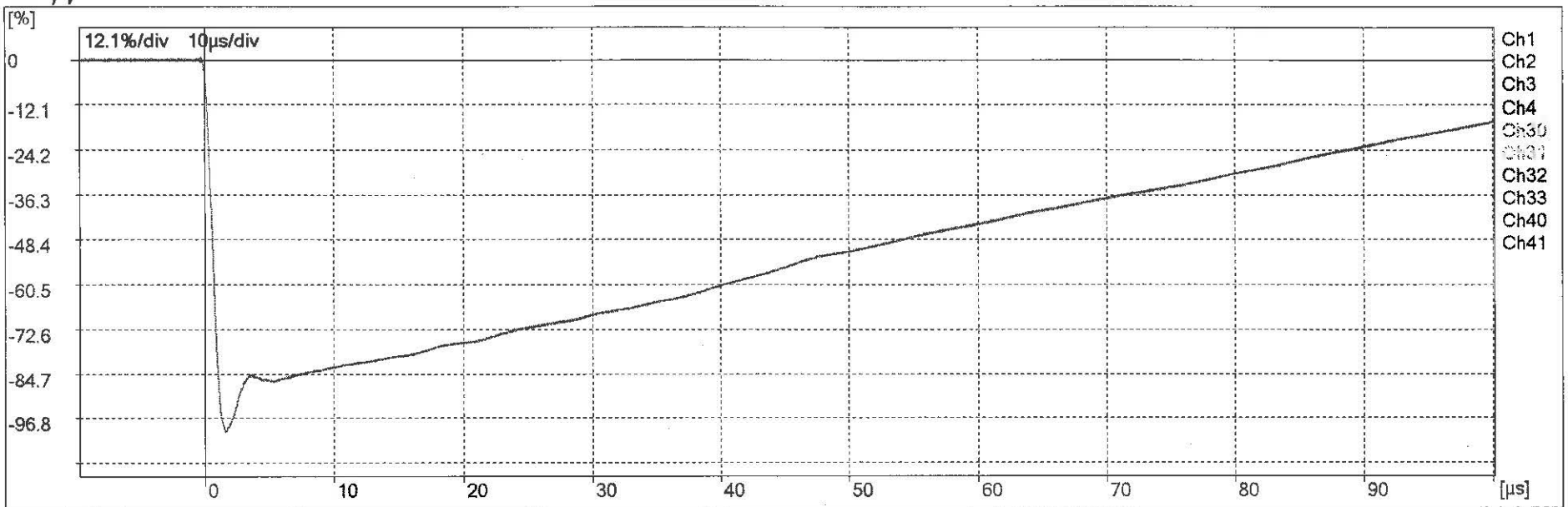


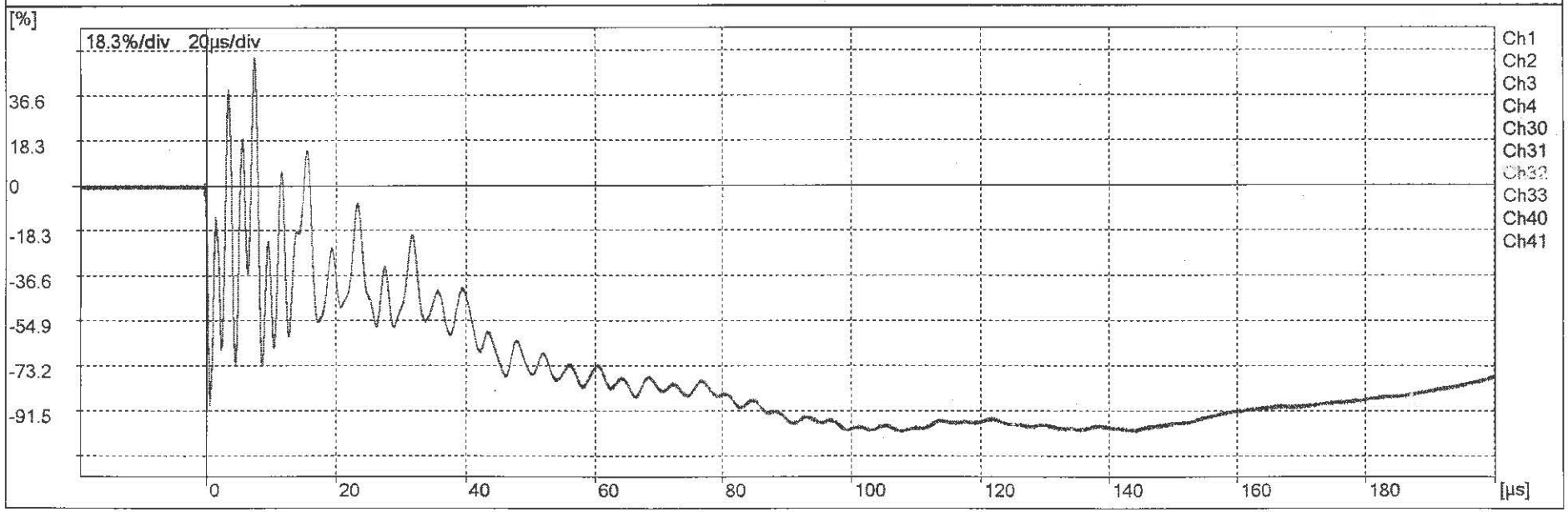
No = 6
Ch1: H1
Up = -651.2 kV
T1 = 1.245 μs
T2 = 51.96 μs
Ch2:
H2+H3+LV+H0X0
+Ip = 363.3 A
-Ip = -695.4 A

H1 Tap 5 /16R 62% LI RW

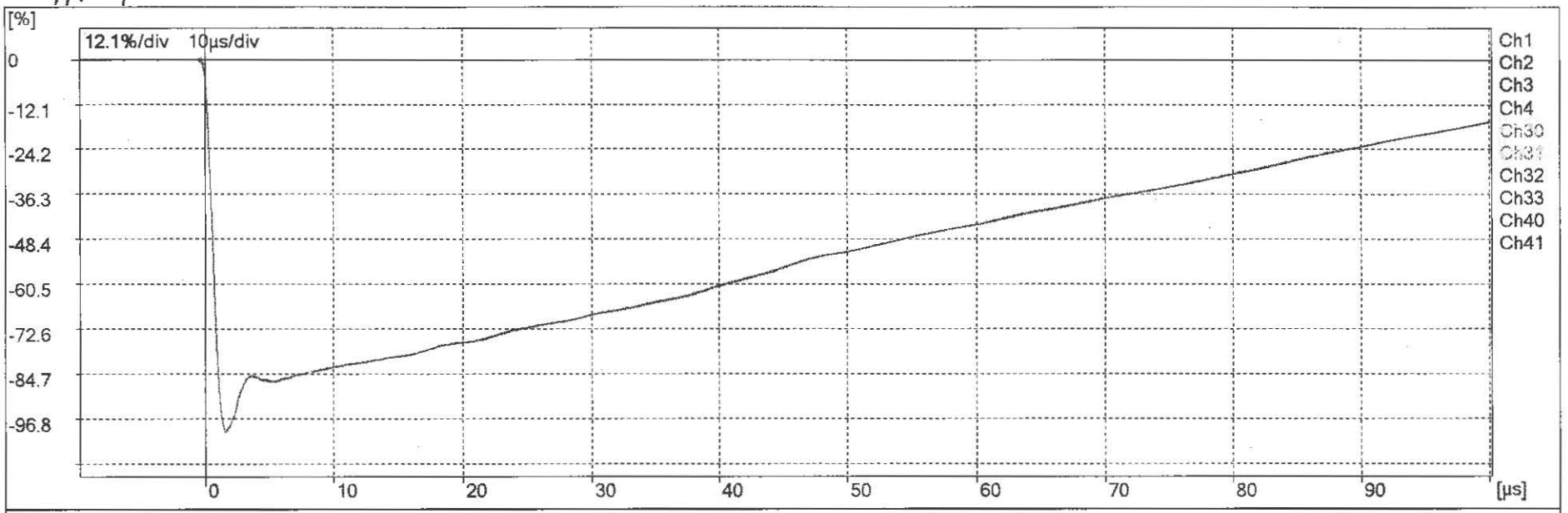
Date of test : 2/24/2013	Tested by : C. S. Ha

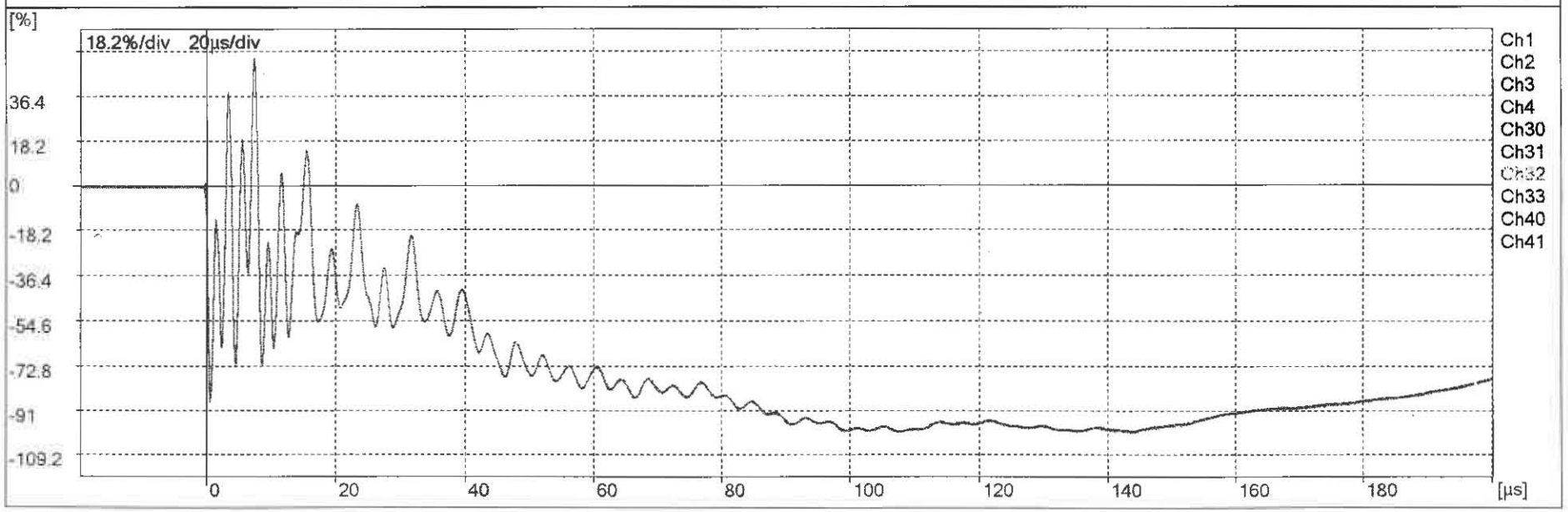
H1 R.Fw - R.Fw


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

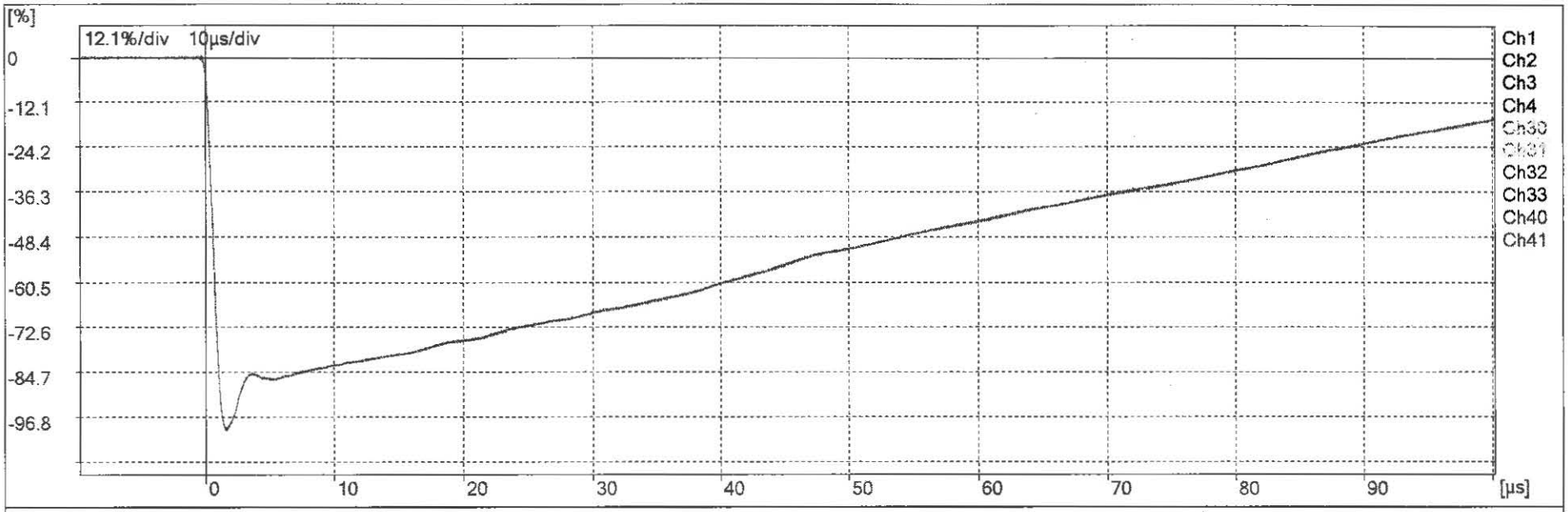

[%]
18.3%/div 20µs/div
36.6
18.3
0
-18.3
-36.6
-54.9
-73.2
-91.5
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

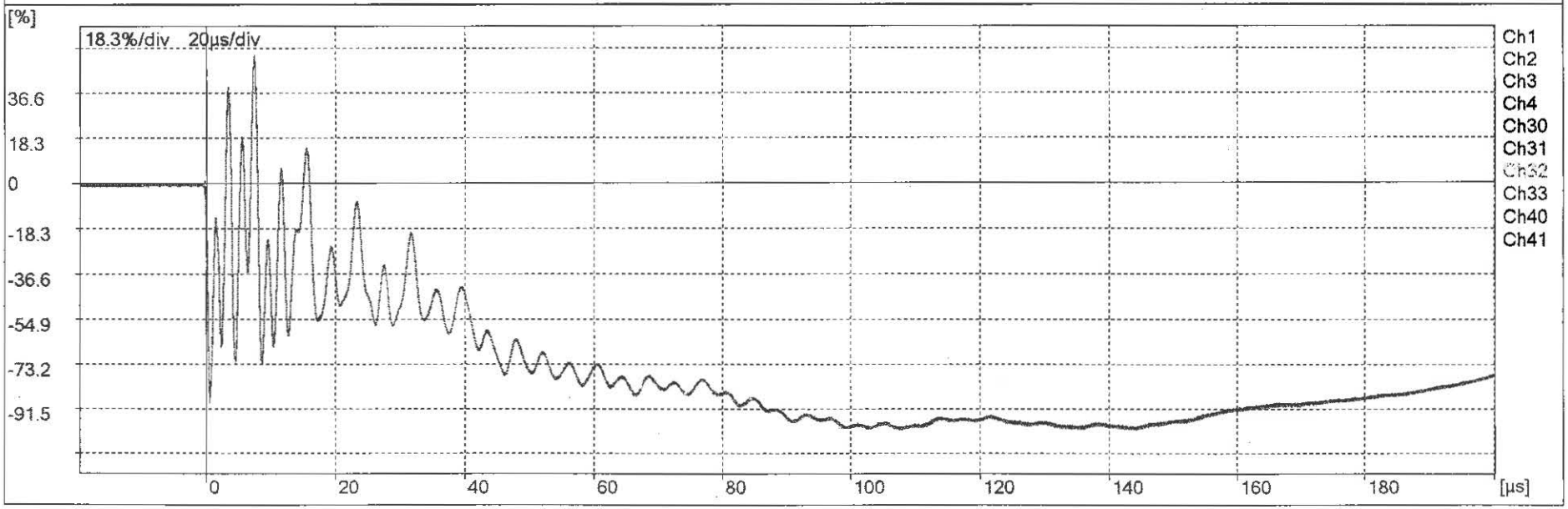
H1 FW - FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
18.2%/div 20µs/div
36.4
18.2
0
-18.2
-36.4
-54.6
-72.8
-91
-109.2
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

H, R.FW – FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

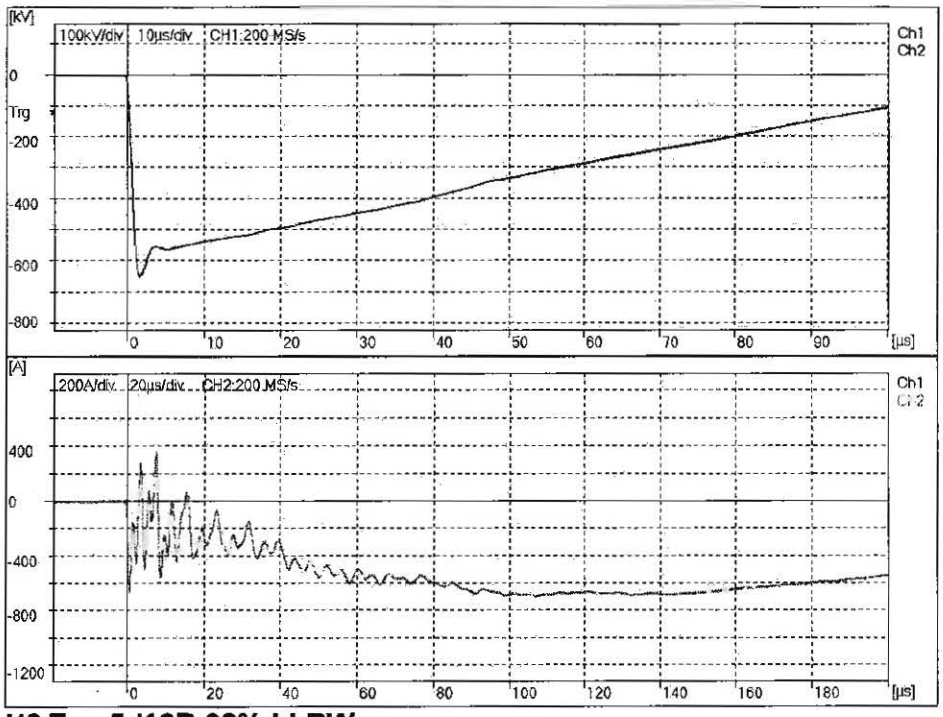

[%]
18.3%/div 20µs/div
36.6
18.3
0
-18.3
-36.6
-54.9
-73.2
-91.5
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

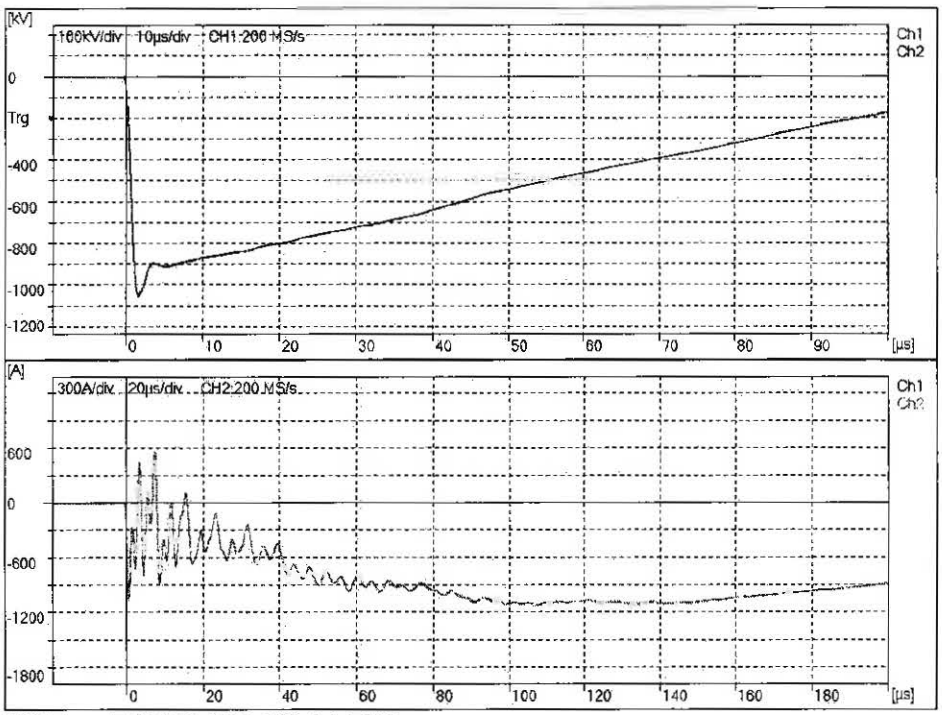
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: H2
Up = -650.3 kV
T1 = 1.240 μs
T2 = 51.86 μs
Ch2:
H1+H3+LV+H0X0
+Ip = 359.2 A
-Ip = -697.5 A

H2 Tap 5 /16R 62% LI RW



No = 2
Ch1: H2
Up = -1048 kV
T1 = 1.250 μs
T2 = 52.13 μs
Ch2:
H1+H3+LV+H0X0
+Ip = 571.3 A
-Ip = -1124 A

H2 Tap 5 /16R 100.1% LI FW

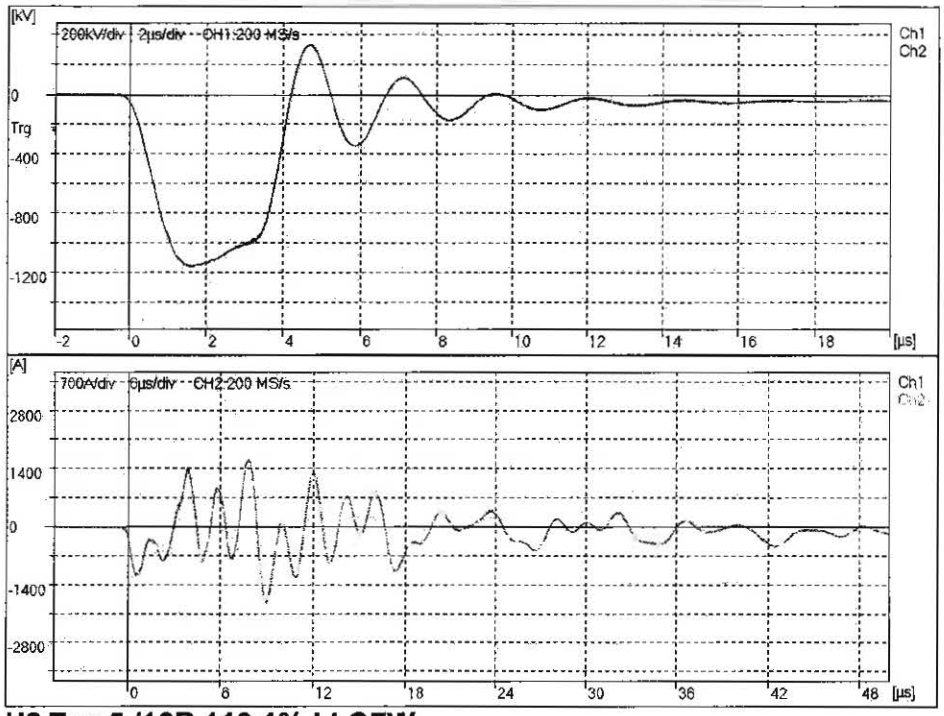
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

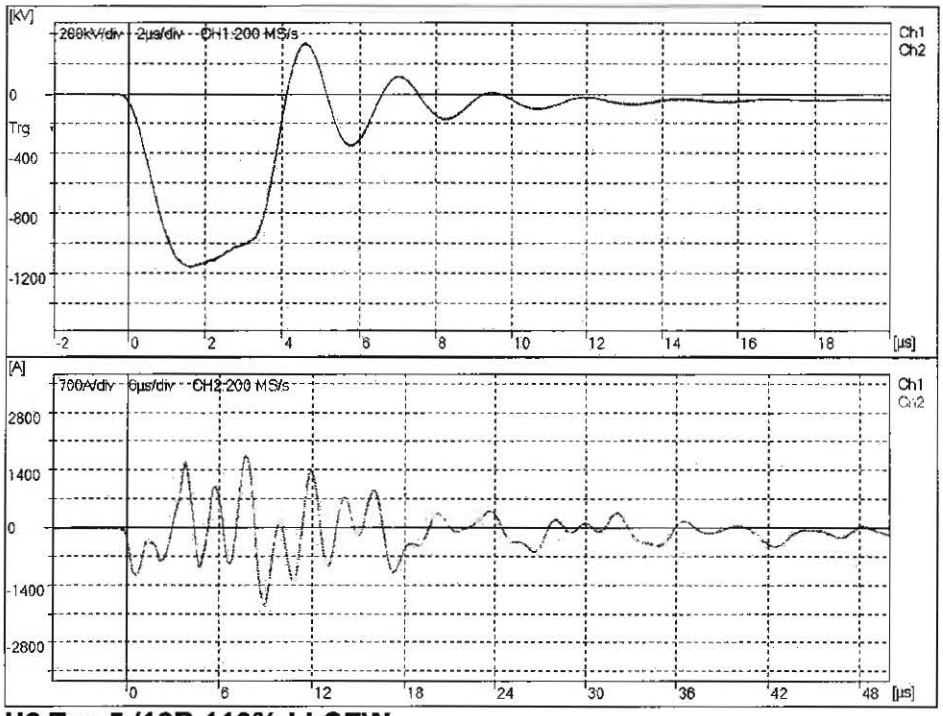
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: H2
Up = -1157 kV
T1 = 1.251 μs
Tc = 3.290 μs
Ch2:
H1+H3+LV+H0X0
+Ip = 1619 A
-Ip = -1833 A

H2 Tap 5 /16R 110.1% LI CFW



No = 4
Ch1: H2
Up = -1155 kV
T1 = 1.249 μs
Tc = 3.201 μs
Ch2:
H1+H3+LV+H0X0
+Ip = 1770 A
-Ip = -1904 A

H2 Tap 5 /16R 110% LI CFW

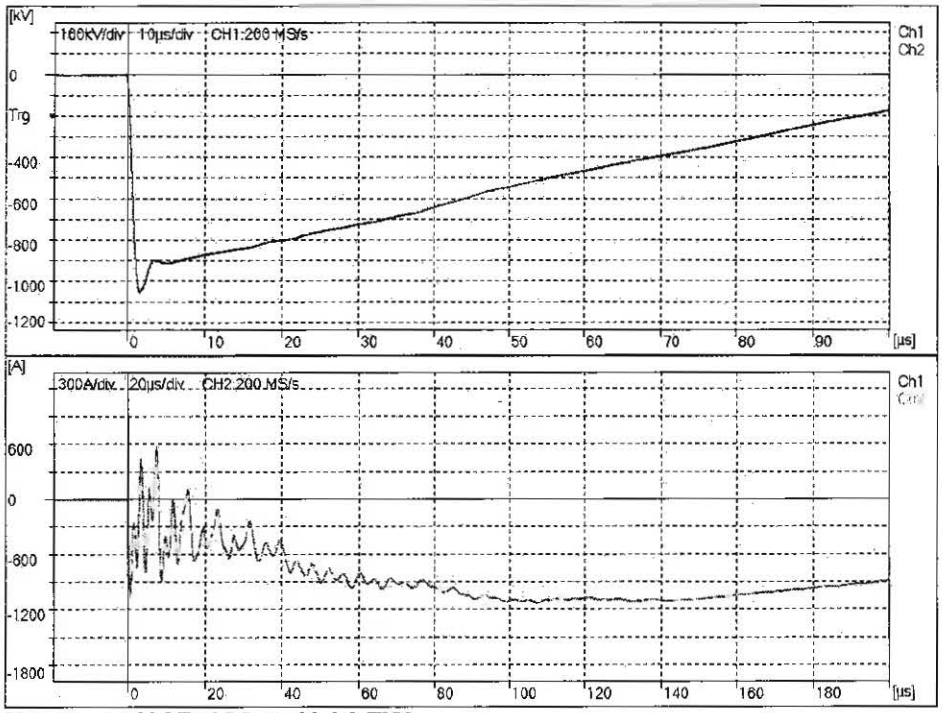
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

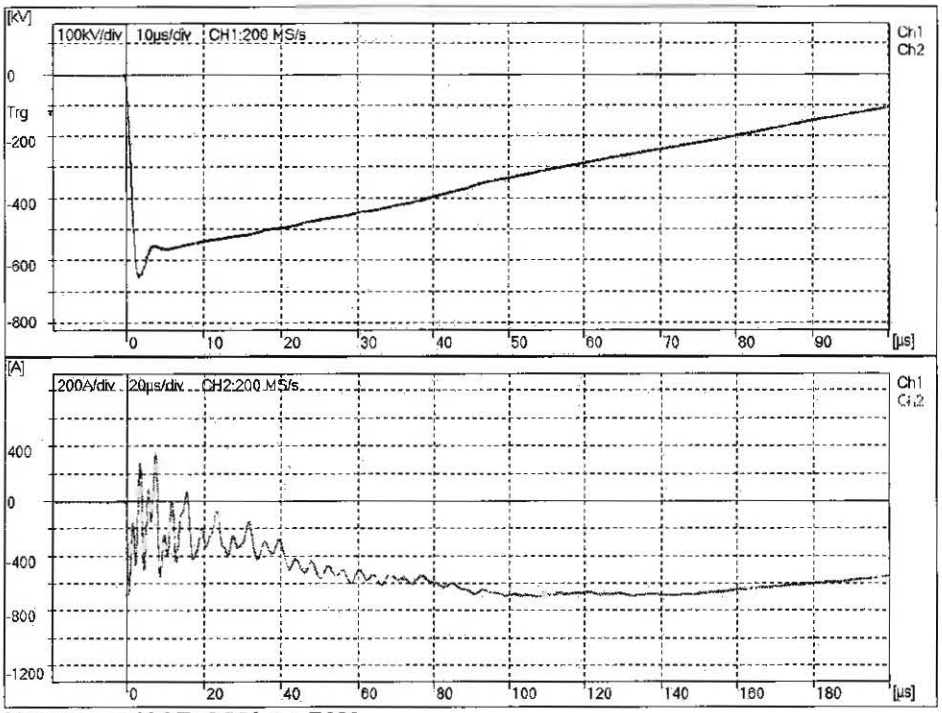
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: H2
Up = -1050 kV
T1 = 1.249 μs
T2 = 52.15 μs
Ch2:
H1+H3+LV+H0X0
+Ip = 574.5 A
-Ip = -1128 A

H2 Tap 5 /16R 100.19% LI FW

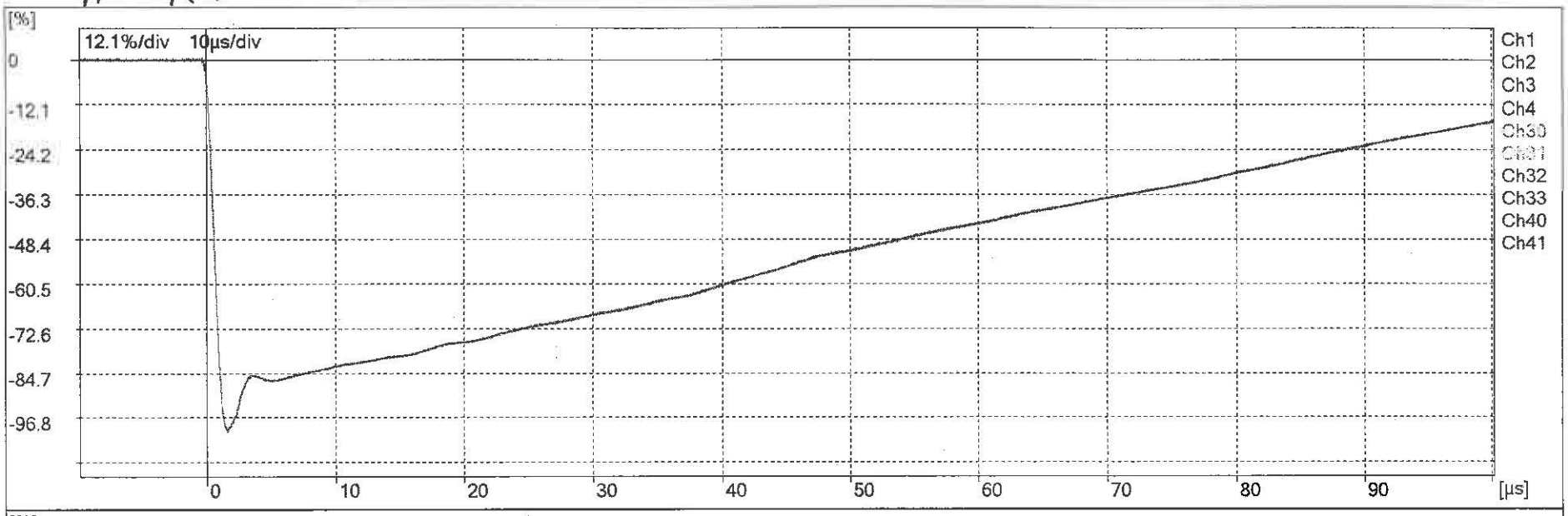


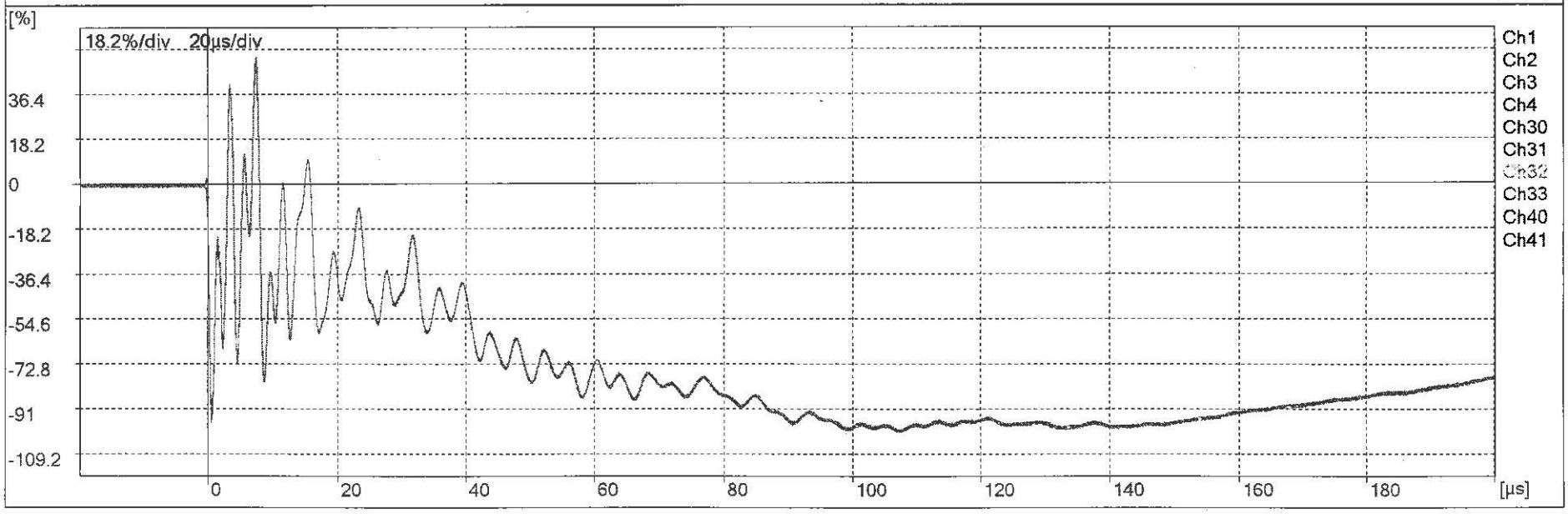
No = 6
Ch1: H2
Up = -650.5 kV
T1 = 1.240 μs
T2 = 51.96 μs
Ch2:
H1+H3+LV+H0X0
+Ip = 358.1 A
-Ip = -699.5 A

H2 Tap 5 /16R 62% LI RW

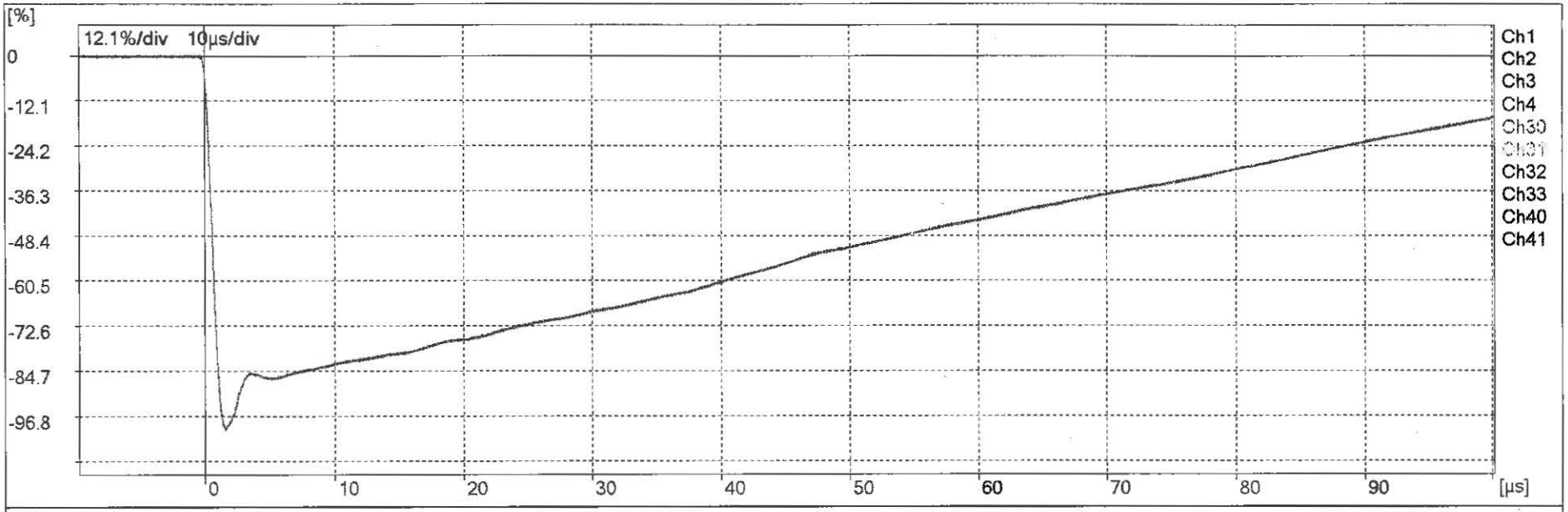
Date of test : 2/24/2013	Tested by : C. S. Ha

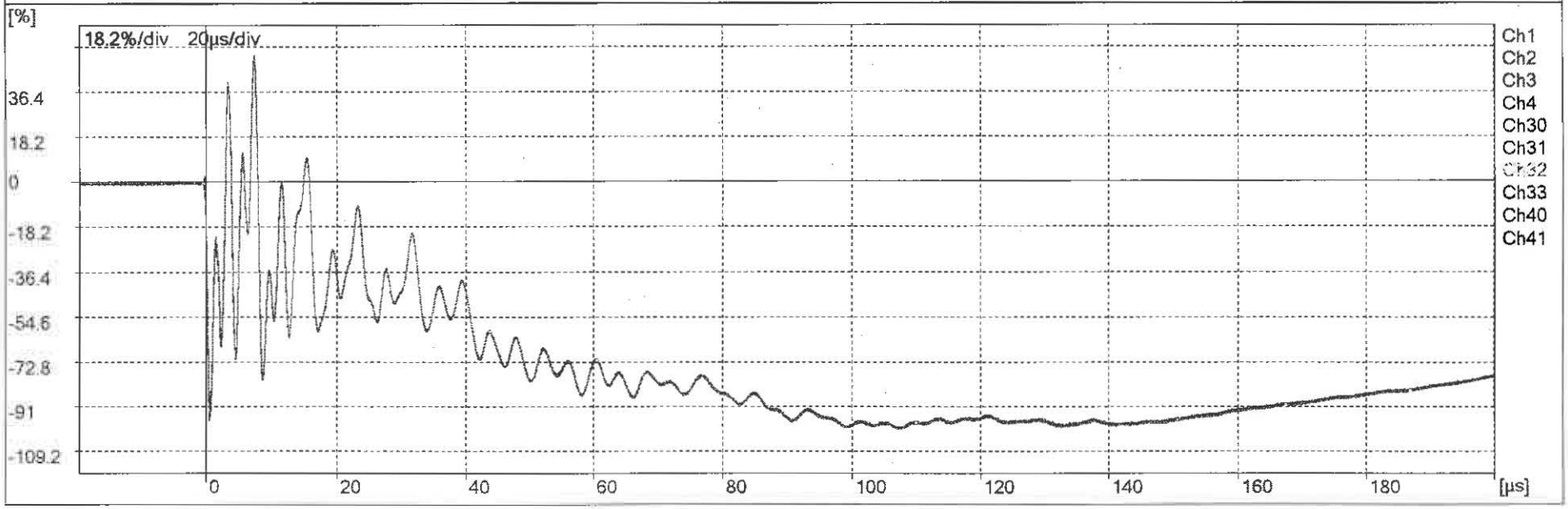
H2 R.FW - R.FW'


[%]
12.1%/div 10μs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[μs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

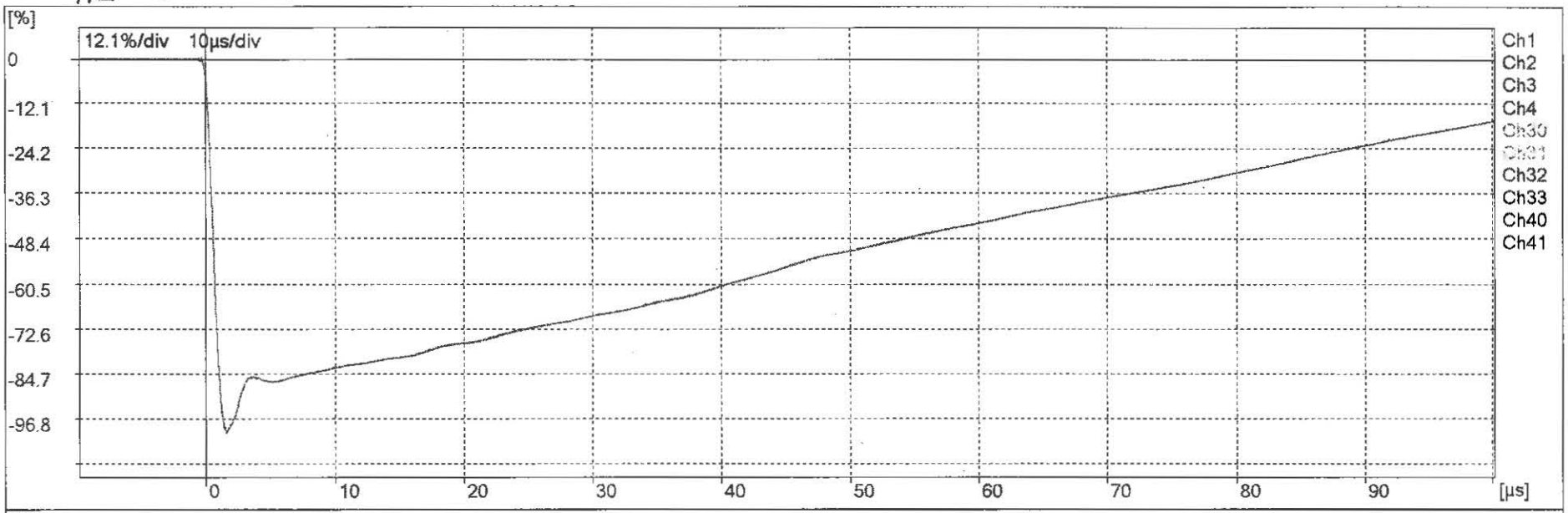

[%]
18.2%/div 20μs/div
36.4
18.2
0
-18.2
-36.4
-54.6
-72.8
-91
-109.2
0
20
40
60
80
100
120
140
160
180
[μs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

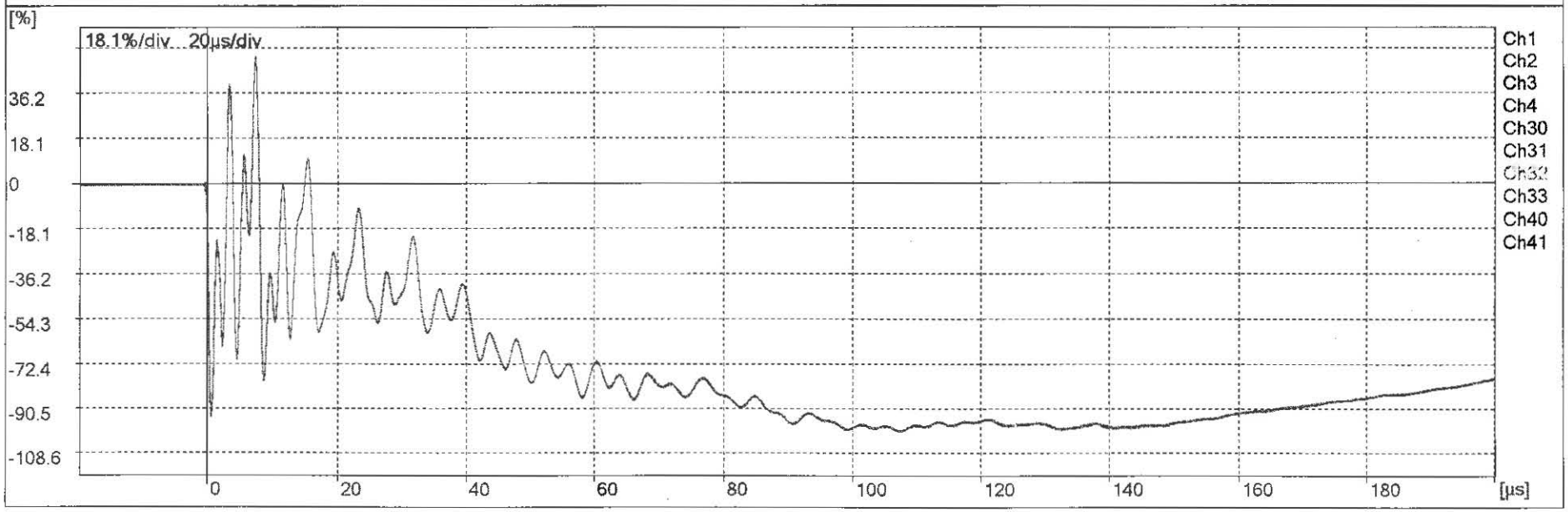
H2 R.FW – FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
18.2%/div 20µs/div
36.4
18.2
0
-18.2
-36.4
-54.6
-72.8
-91
-109.2
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

H2 FW – FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

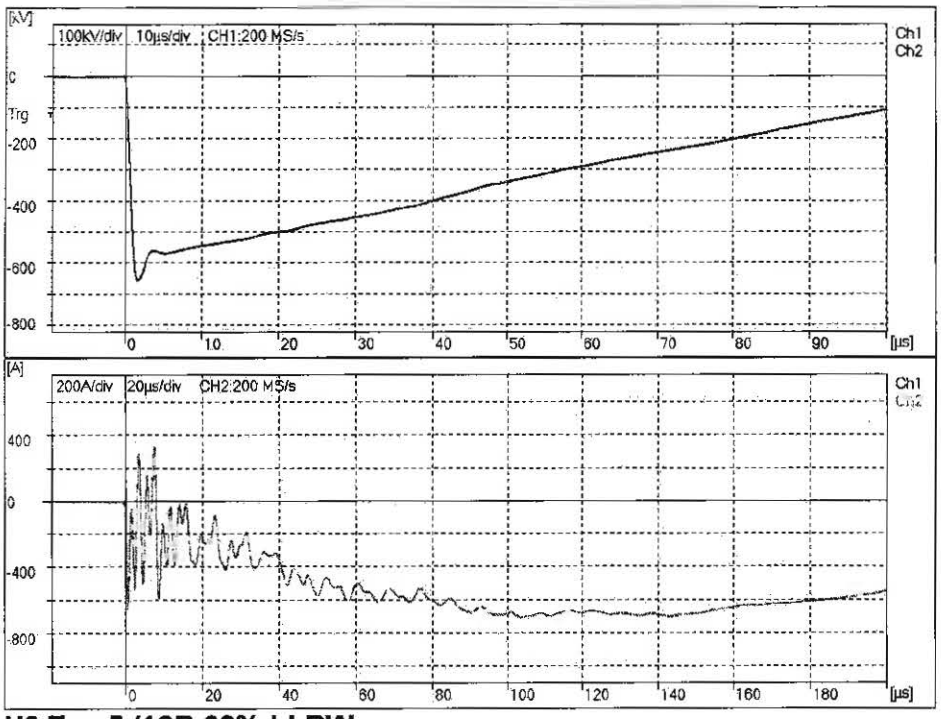

[%]
18.1%/div 20µs/div
36.2
18.1
0
-18.1
-36.2
-54.3
-72.4
-90.5
-108.6
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

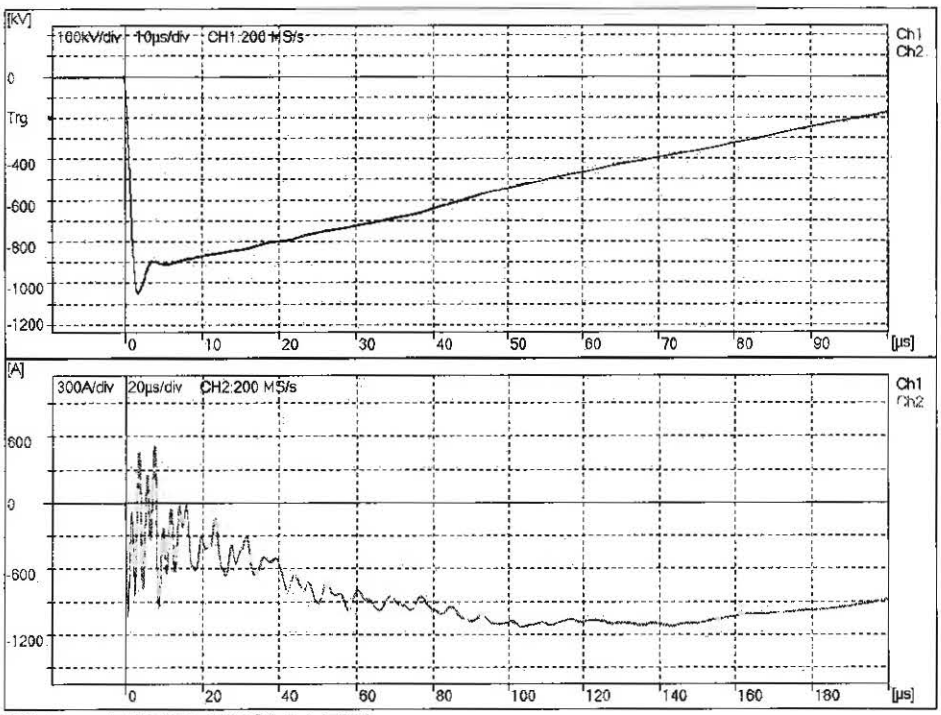
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: H3
Up = -656.0 kV
T1 = 1.255 μs
T2 = 52.04 μs
Ch2:
H1+H2+LV+H0X0
+Ip = 334.2 A
-Ip = -709.0 A

H3 Tap 5 /16R 62% LI RW



No = 2
Ch1: H3
Up = -1045 kV
T1 = 1.263 μs
T2 = 52.36 μs
Ch2:
H1+H2+LV+H0X0
+Ip = 531.7 A
-Ip = -1132 A

H3 Tap 5 /16R 100% LI FW

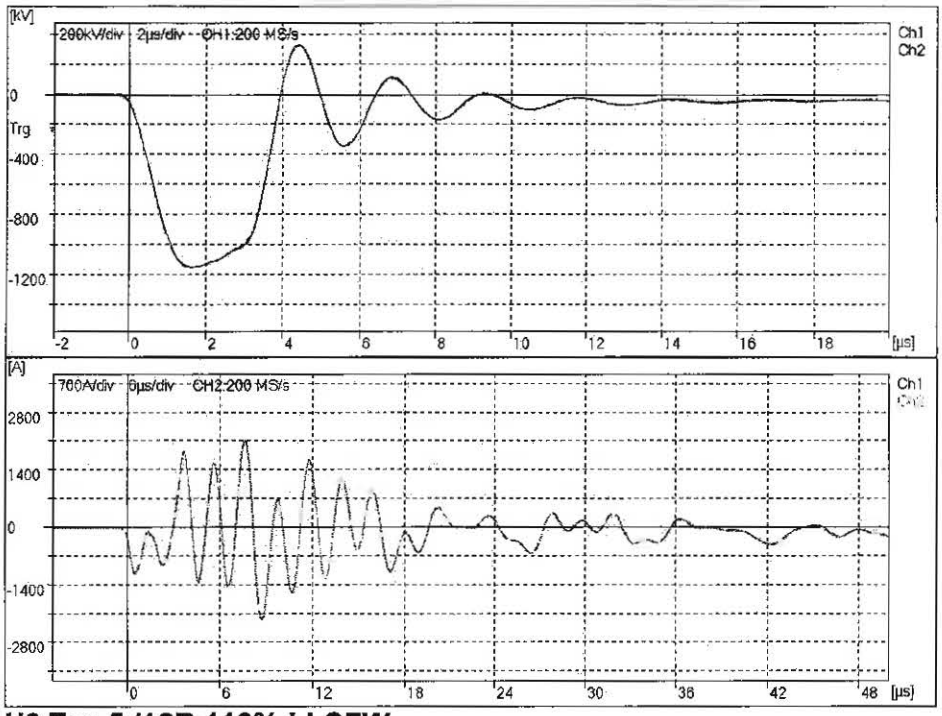
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

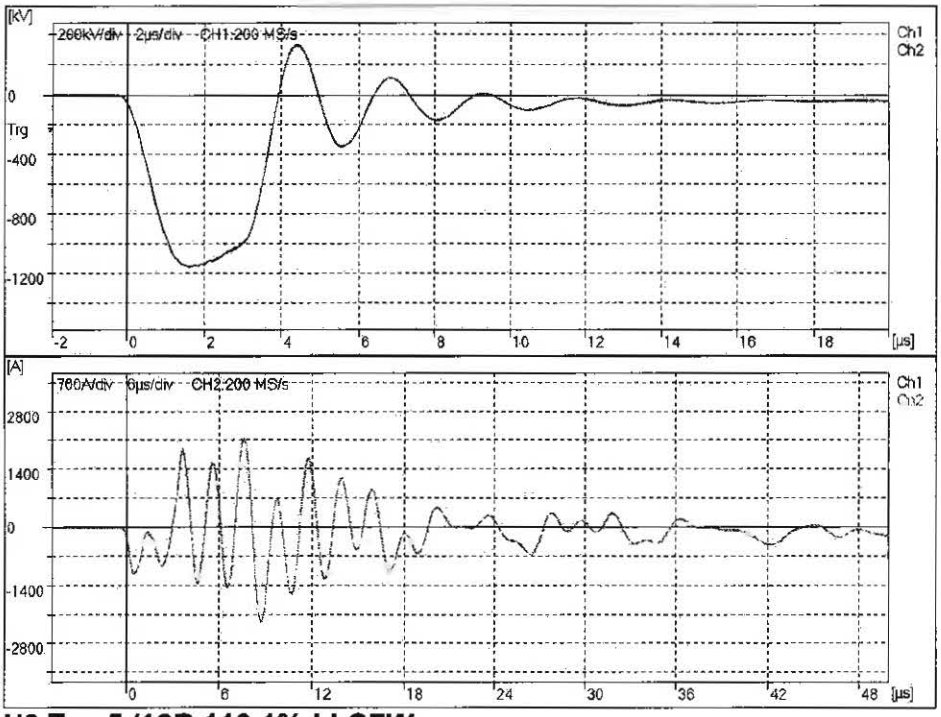
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: H3
Up = -1153 kV
T1 = 1.265 μs
Tc = 3.122 μs
Ch2:
H1+H2+LV+H0X0
+Ip = 2134 A
-Ip = -2263 A

H3 Tap 5 /16R 110% LI CFW



No = 4
Ch1: H3
Up = -1154 kV
T1 = 1.263 μs
Tc = 3.103 μs
Ch2:
H1+H2+LV+H0X0
+Ip = 2157 A
-Ip = -2280 A

H3 Tap 5 /16R 110.1% LI CFW

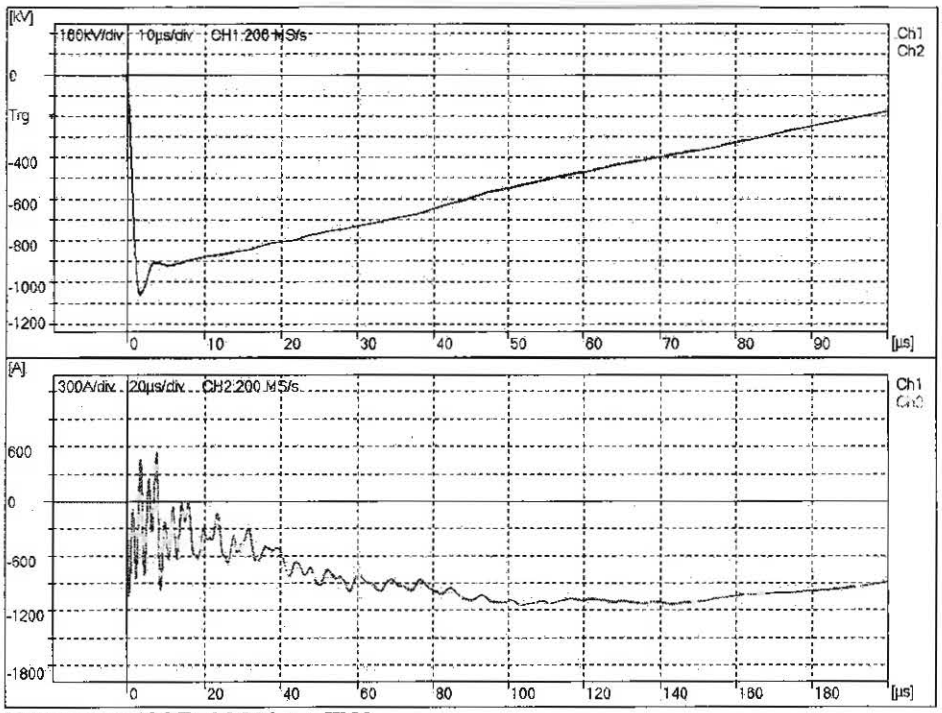
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

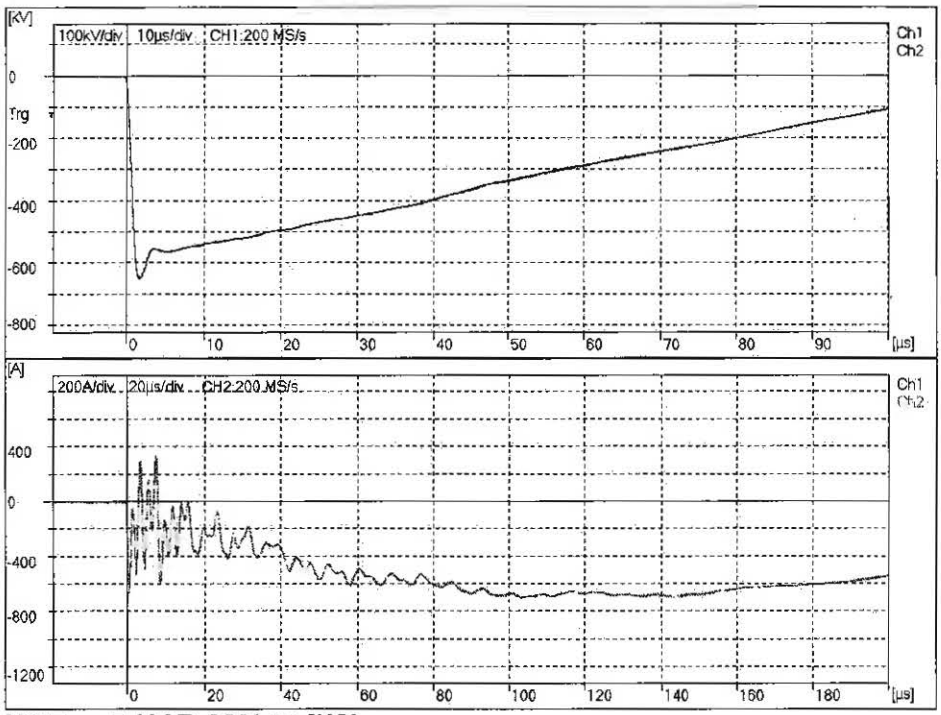
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: H3
Up = -1055 kV
T1 = 1.263 μs
T2 = 52.33 μs
Ch2:
H1+H2+LV+H0X0
+Ip = 539.1 A
-Ip = -1141 A

H3 Tap 5 /16R 100% LI FW

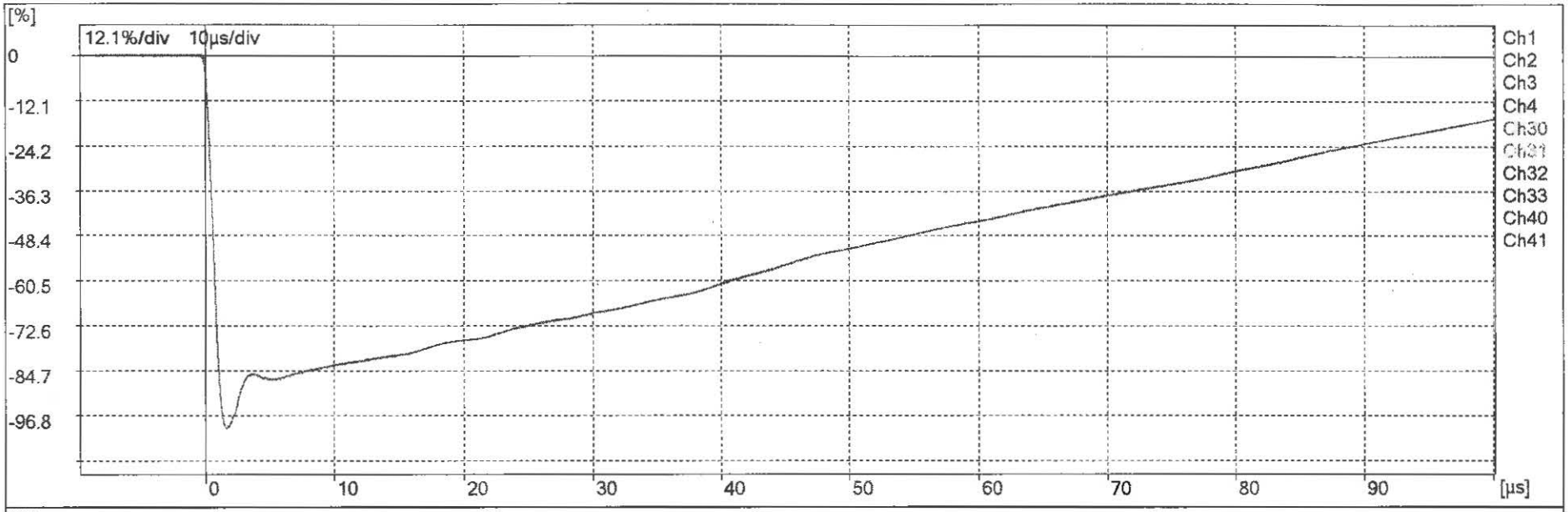


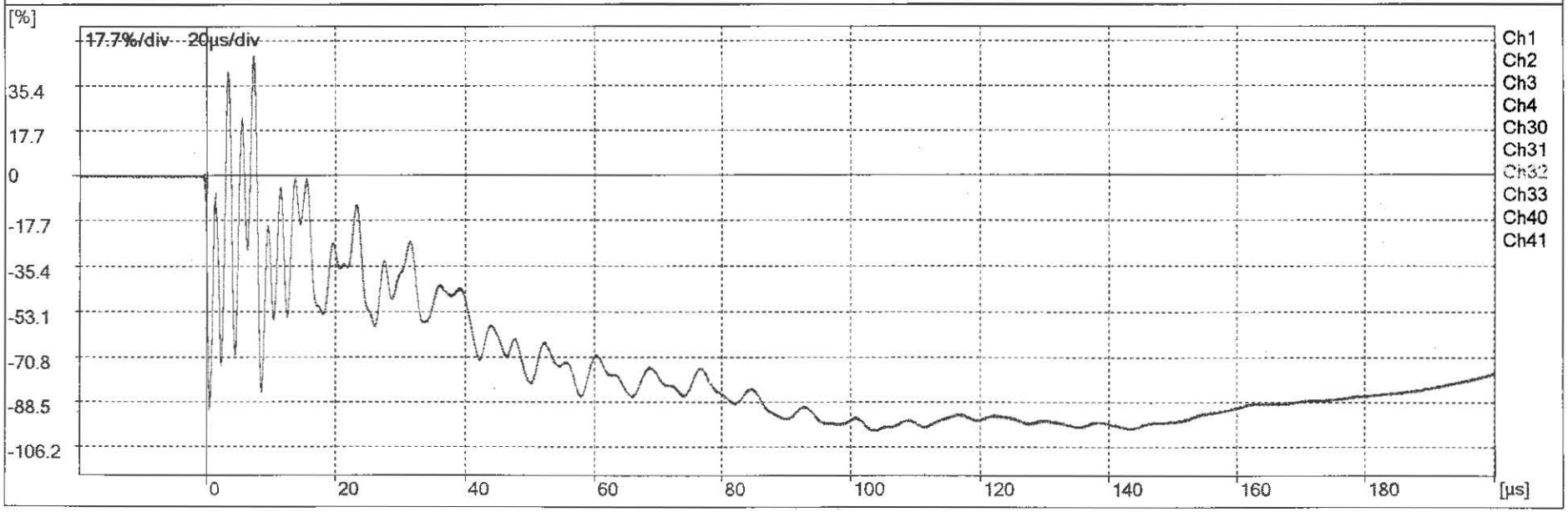
No = 6
Ch1: H3
Up = -649.3 kV
T1 = 1.255 μs
T2 = 52.16 μs
Ch2:
H1+H2+LV+H0X0
+Ip = 334.2 A
-Ip = -704.7 A

H3 Tap 5 /16R 62% LI RW

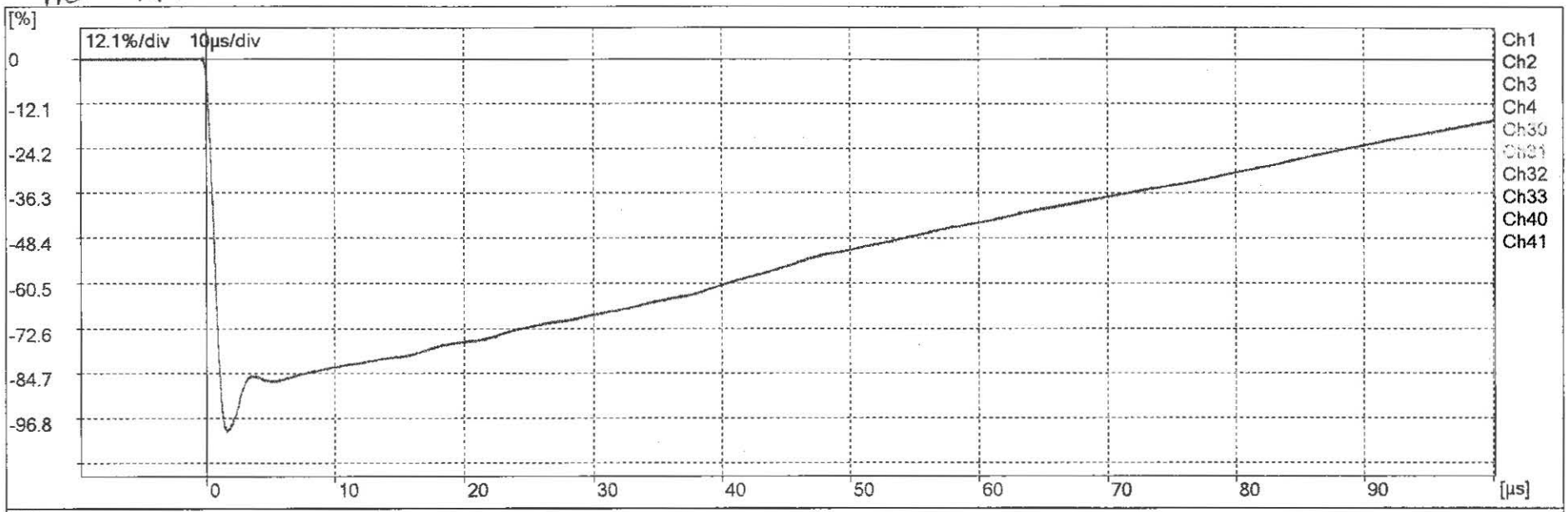
Date of test : 2/24/2013	Tested by : C. S. Ha

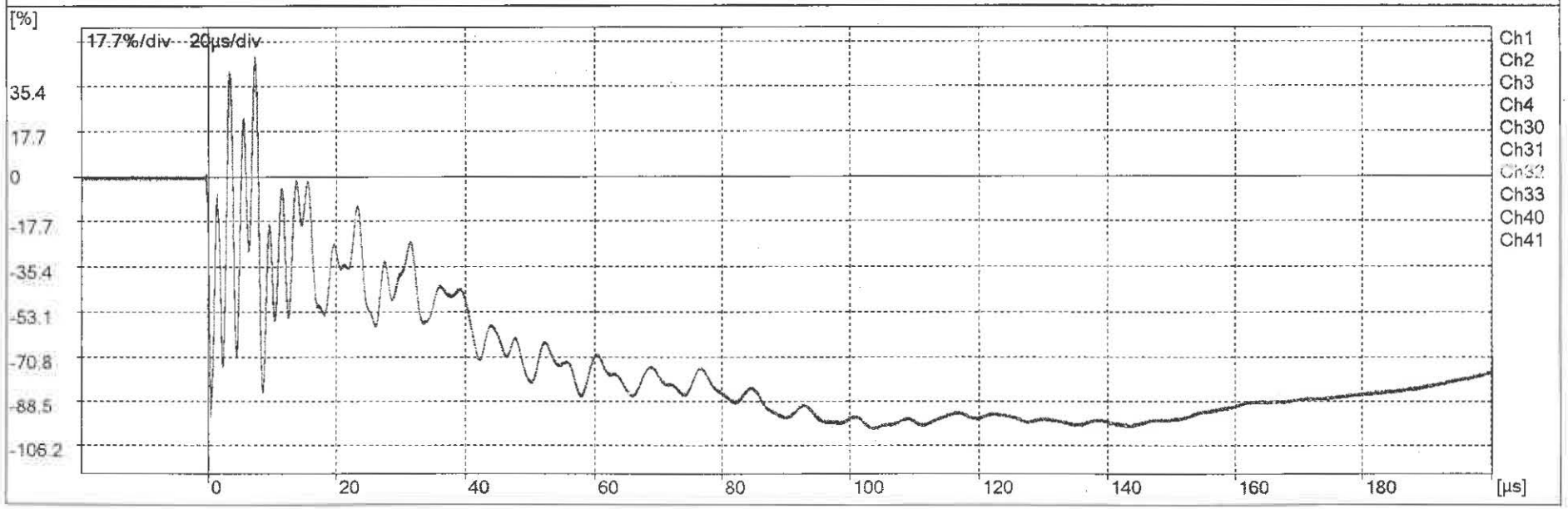
H3 FIW − FIW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

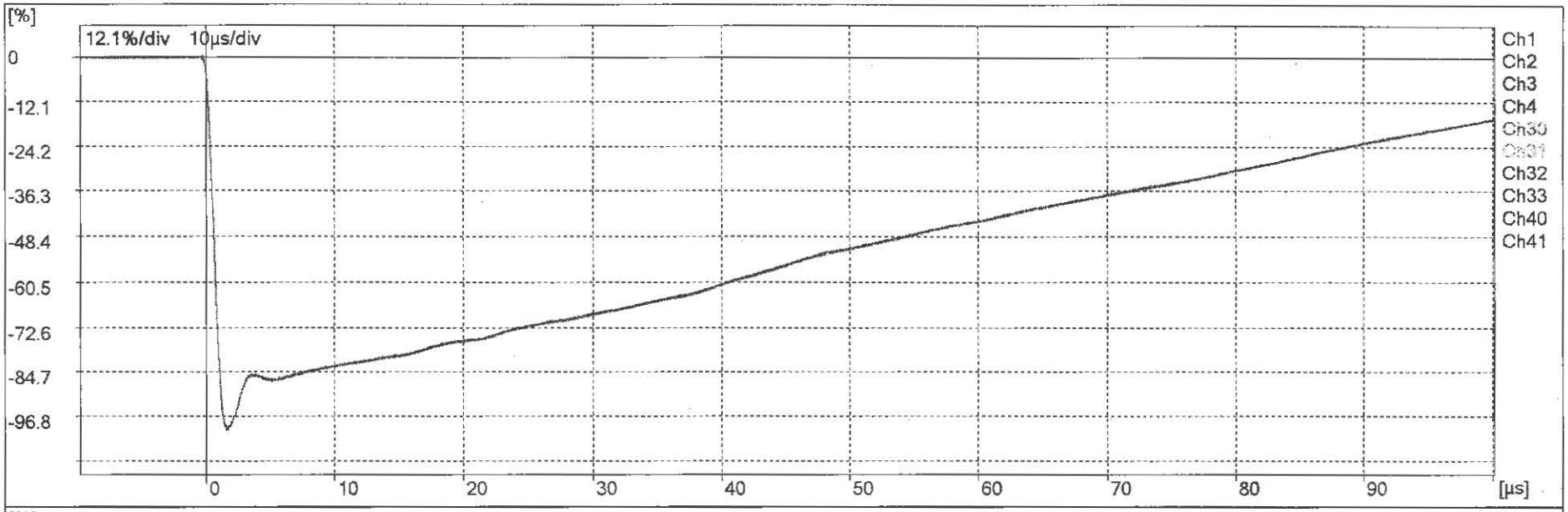

[%]
17.7%/div 20µs/div
35.4
17.7
0
-17.7
-35.4
-53.1
-70.8
-88.5
-106.2
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

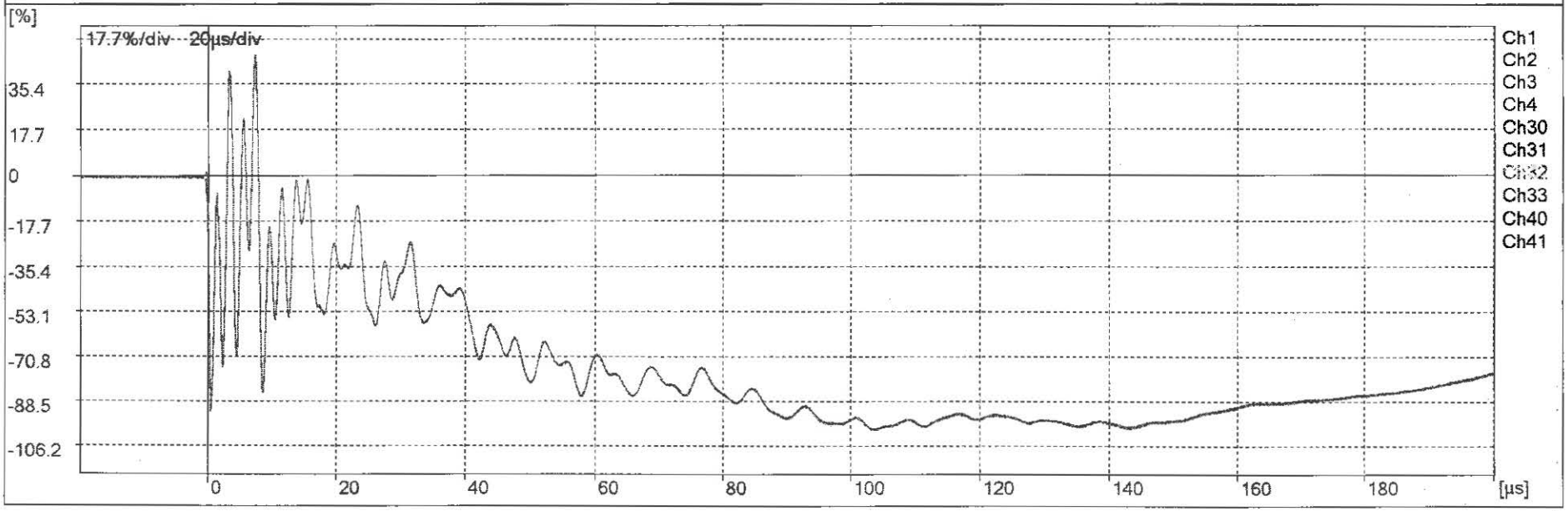
H3 R.FW - R.FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
17.7%/div 20µs/div
35.4
17.7
0
-17.7
-35.4
-53.1
-70.8
-88.5
-106.2
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

H3 R.FW – FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

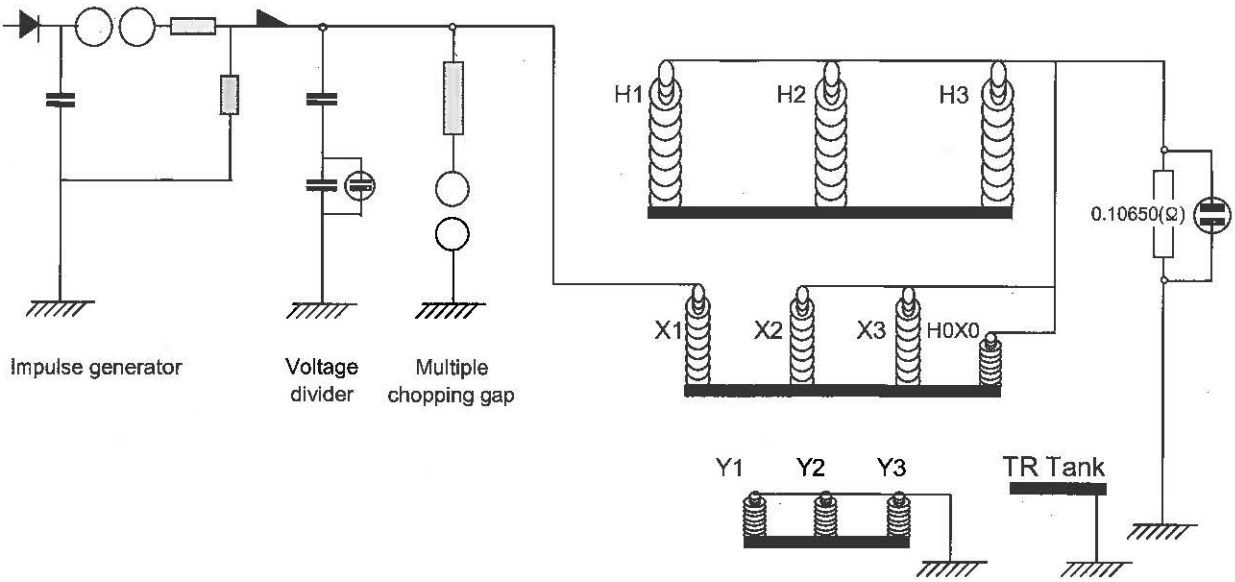

[%]
17.7%/div 20µs/div
35.4
17.7
0
-17.7
-35.4
-53.1
-70.8
-88.5
-106.2
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning impulse voltage withstand test

Serial No.
20120871TKE001

Lightning impulse voltage test with LV winding



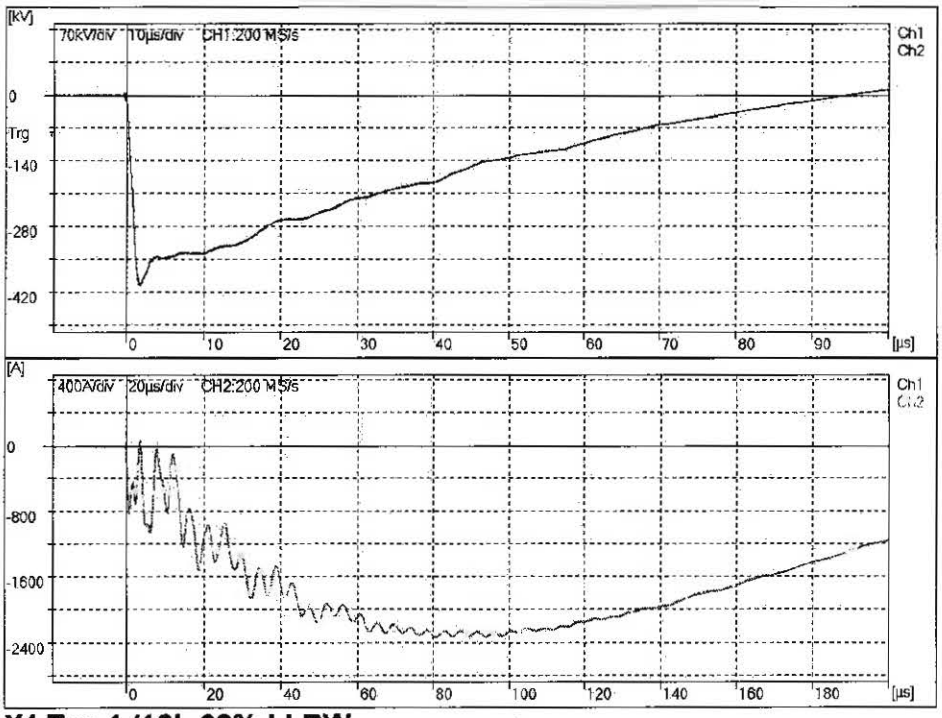
Date of Test : 2013. 02. 24	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

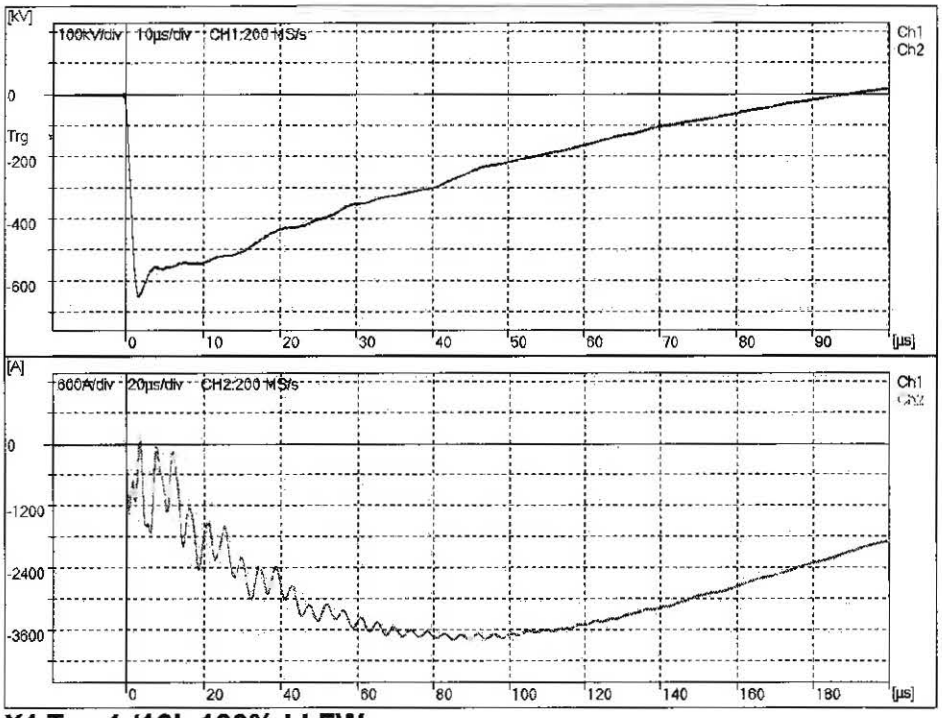
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: X1
Up = -402.7 kV
T1 = 1.425 µs
T2 = 34.42 µs
Ch2:
X2+X3+HV+H0X0
+Ip = 71.46 A
-Ip = -2335 A

X1 Tap 1 /16L 62% LI RW



No = 2
Ch1: X1
Up = -650.1 kV
T1 = 1.438 µs
T2 = 35.06 µs
Ch2:
X2+X3+HV+H0X0
+Ip = 116.9 A
-Ip = -3789 A

X1 Tap 1 /16L 100% LI FW

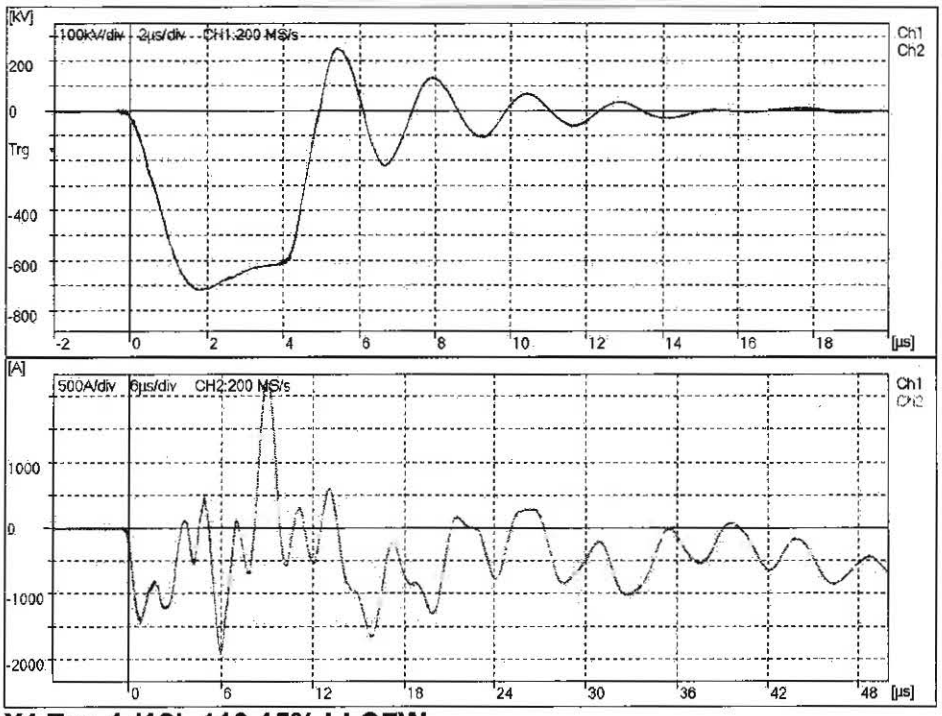
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

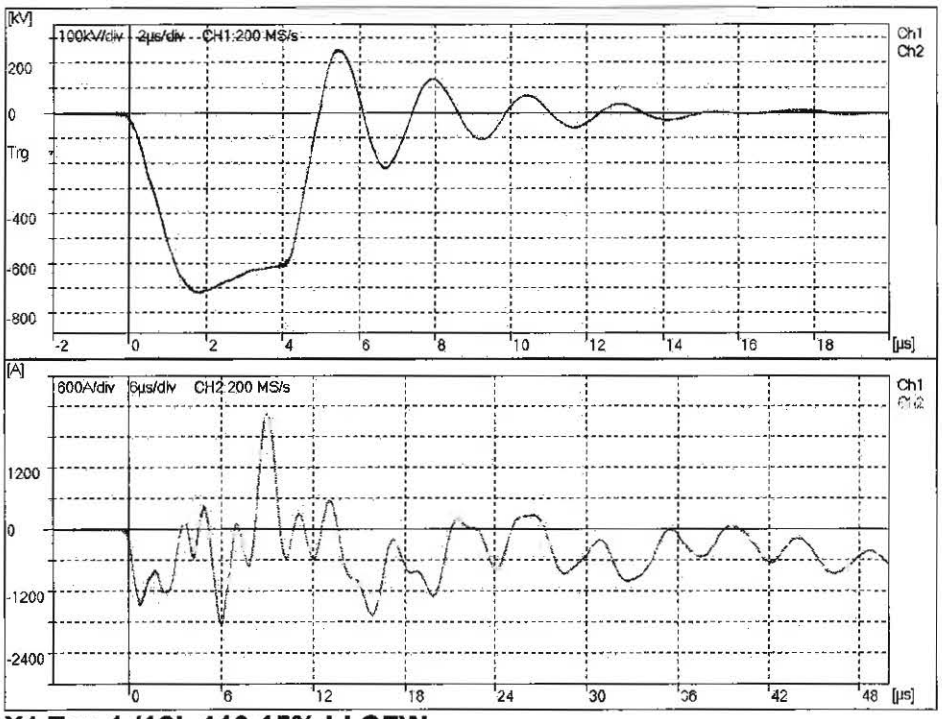
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: X1
Up = -716.2 kV
T1 = 1.443 μs
Tc = 4.102 μs
Ch2:
X2+X3+HV+H0X0
+Ip = 2239 A
-Ip = -1894 A

X1 Tap 1 /16L 110.15% LI CFW



No = 4
Ch1: X1
Up = -716.1 kV
T1 = 1.439 μs
Tc = 4.141 μs
Ch2:
X2+X3+HV+H0X0
+Ip = 2270 A
-Ip = -1860 A

X1 Tap 1 /16L 110.15% LI CFW

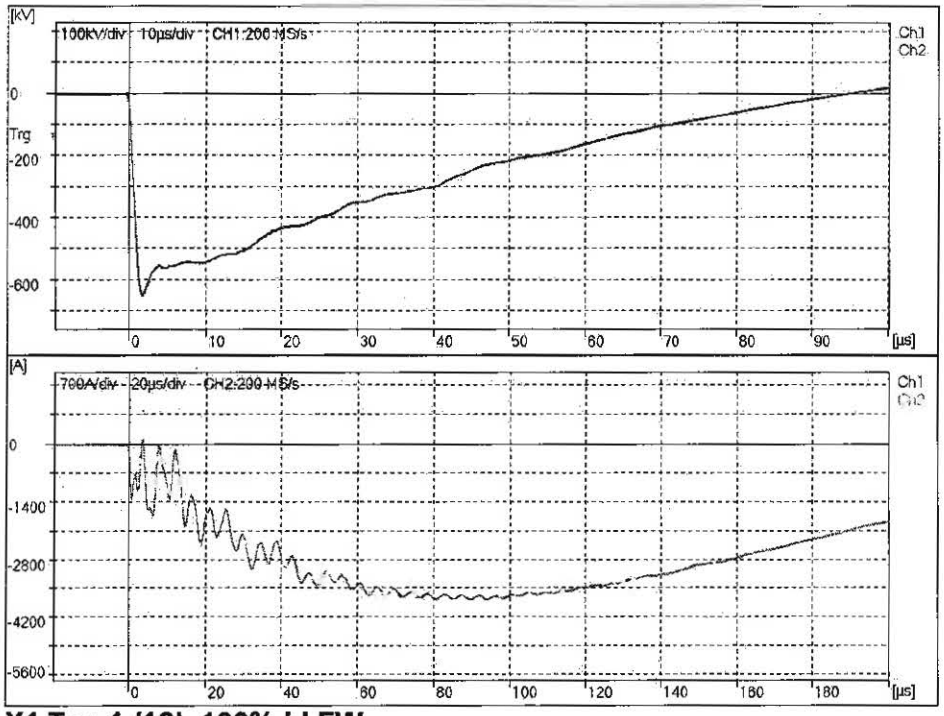
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

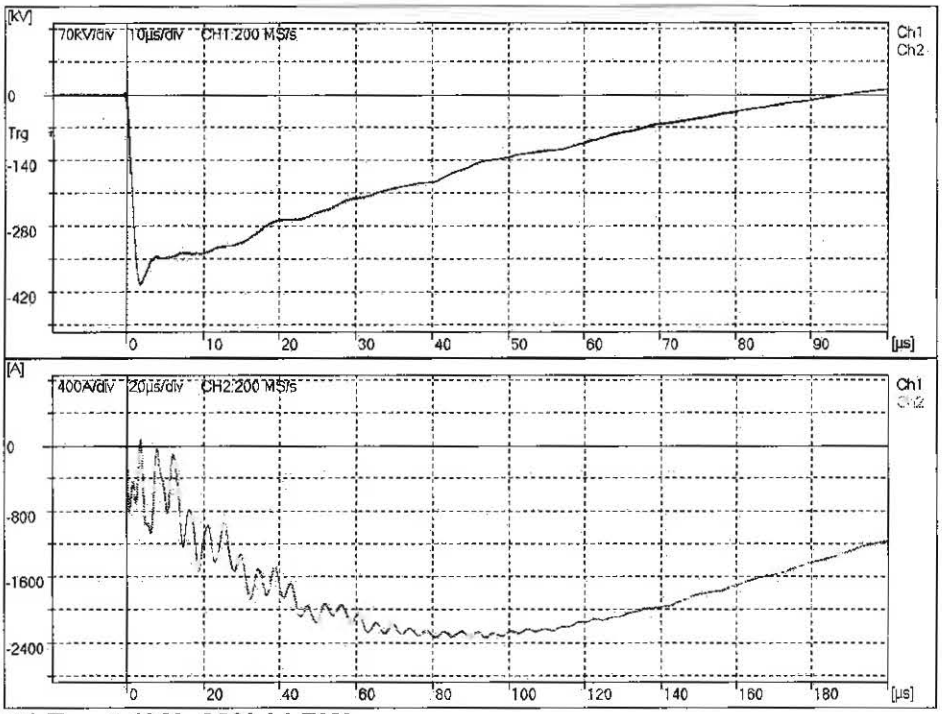
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: X1
Up = -649.7 kV
T1 = 1.437 μs
T2 = 34.35 μs
Ch2:
X2+X3+HV+H0X0
+Ip = 111.5 A
-Ip = -3786 A

X1 Tap 1 /16L 100% LI FW

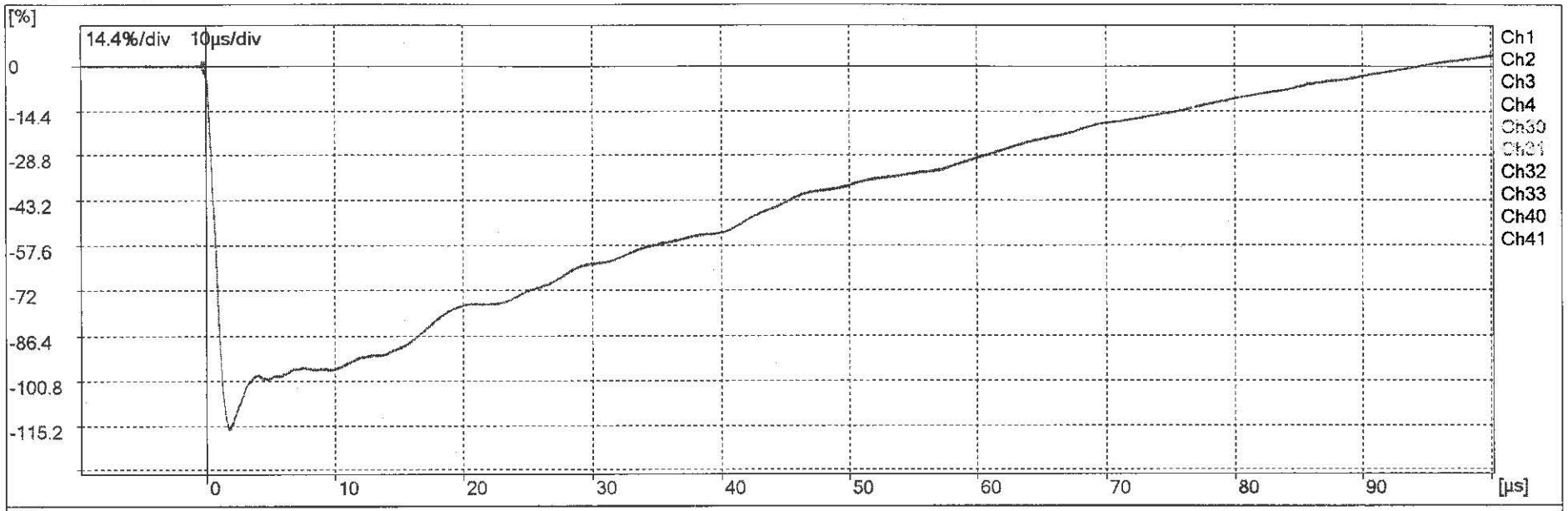


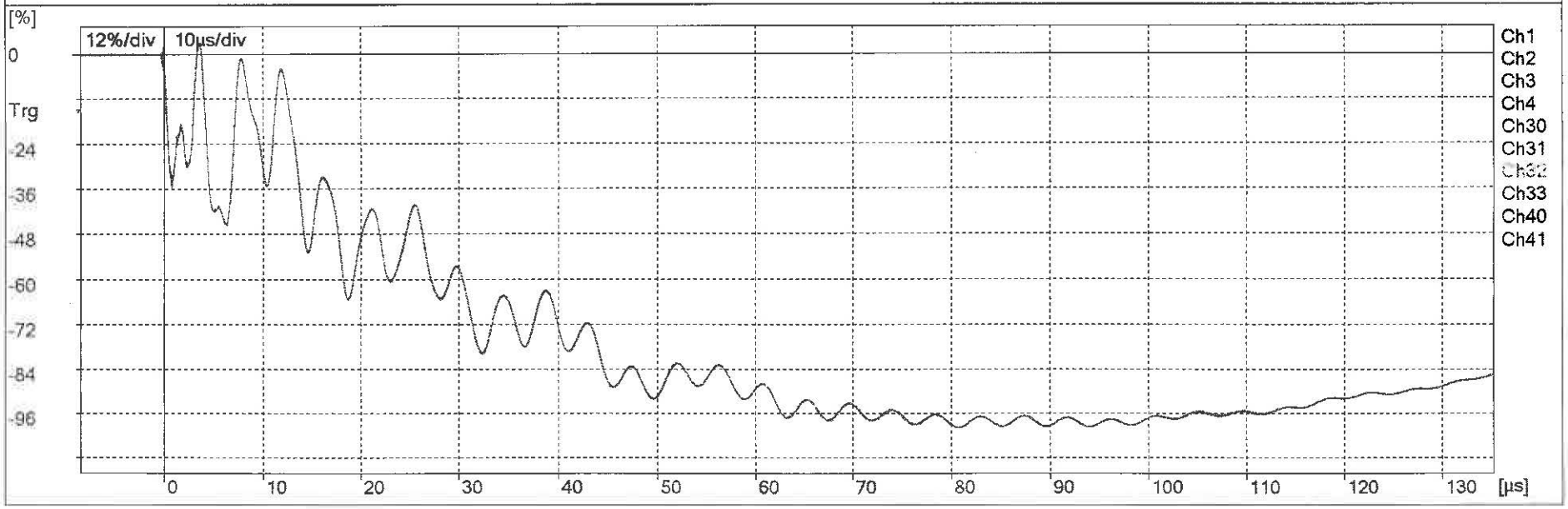
No = 6
Ch1: X1
Up = -403.1 kV
T1 = 1.428 μs
T2 = 34.34 μs
Ch2:
X2+X3+HV+H0X0
+Ip = 73.53 A
-Ip = -2338 A

X1 Tap 1 /16L 62% LI RW

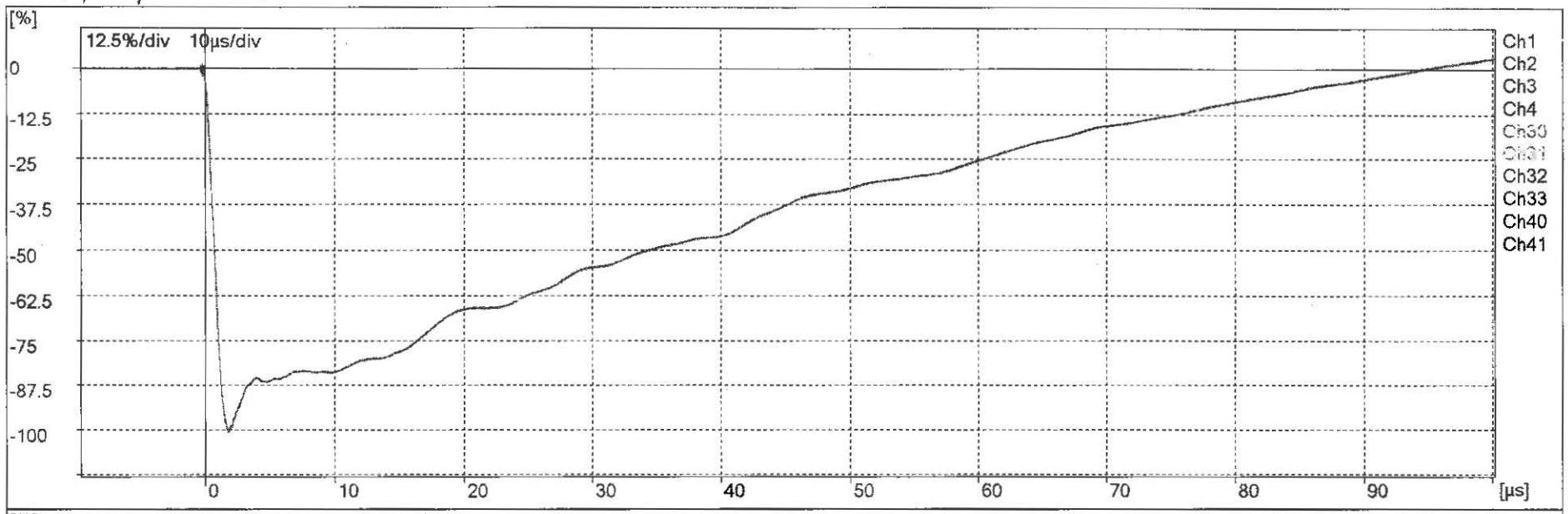
Date of test : 2/24/2013	Tested by : C. S. Ha

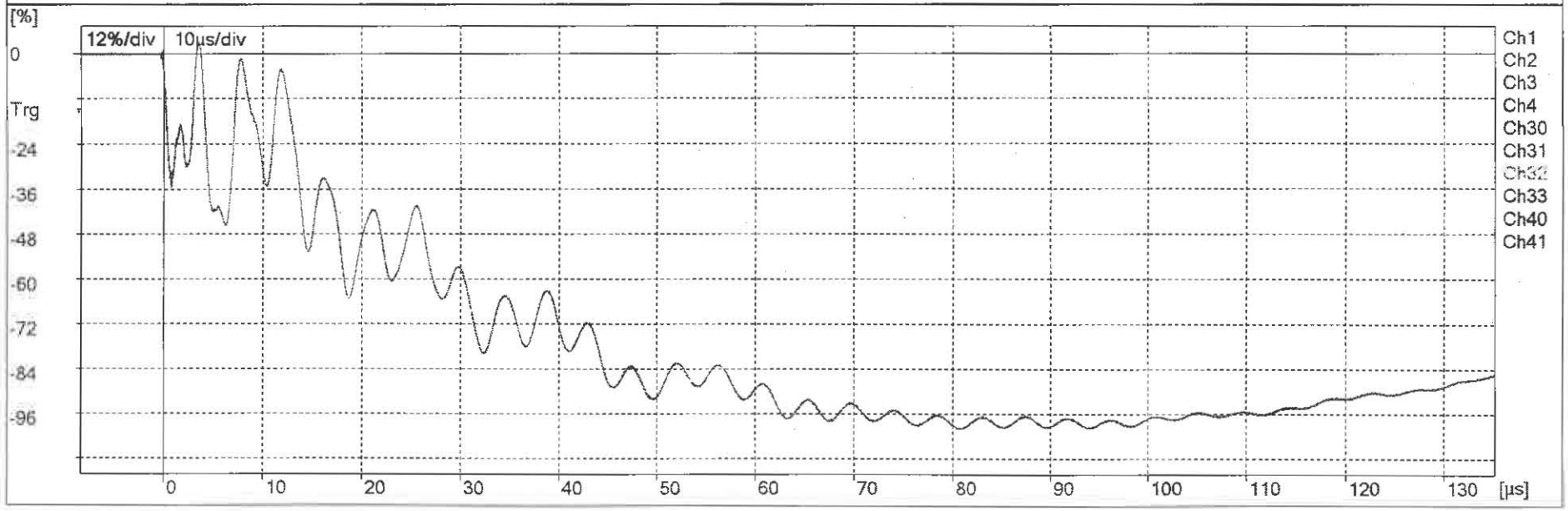
X1 R.Fw – R.Fw


[%]
14.4%/div 10µs/div
0
-14.4
-28.8
-43.2
-57.6
-72
-86.4
-100.8
-115.2
0 10 20 30 40 50 60 70 80 90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

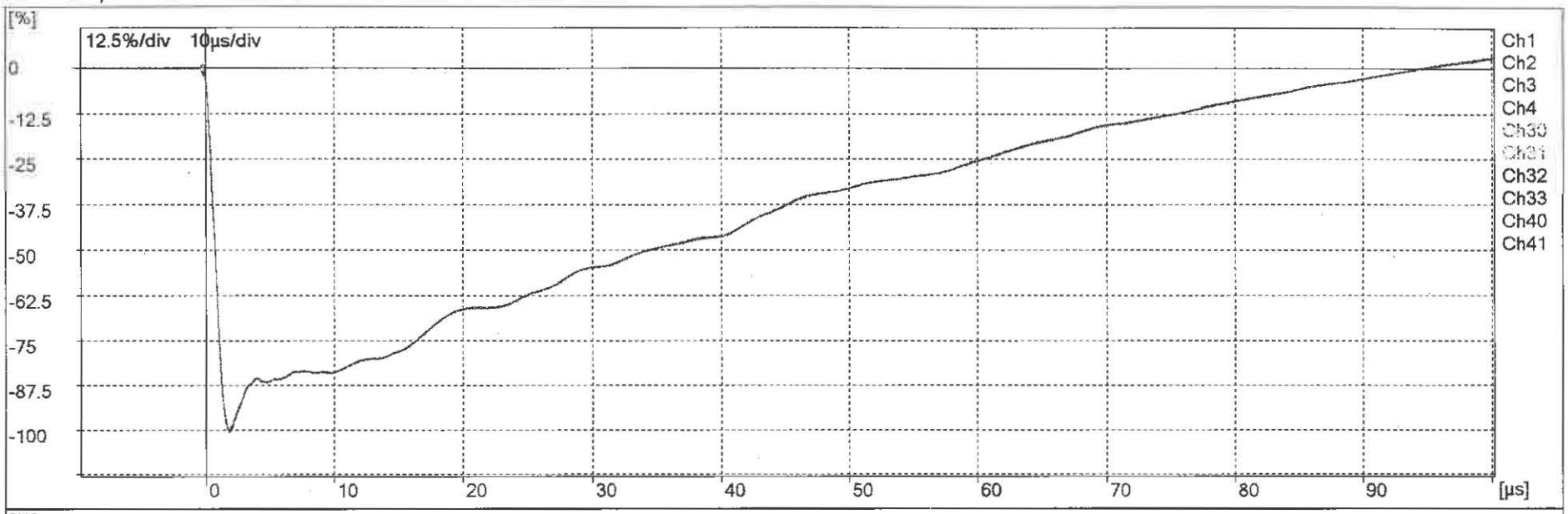

[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

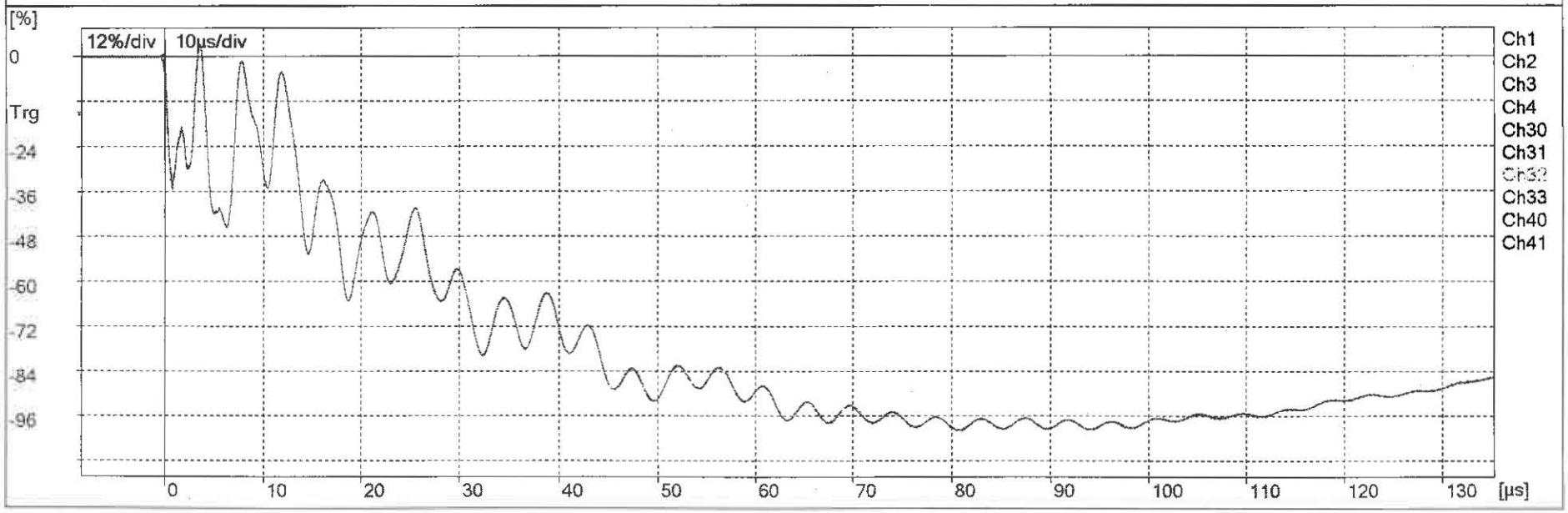
X1 FW - FW


[%]
12.5%/div 10µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0 10 20 30 40 50 60 70 80 90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

X_1 R-Fw − Fw


[%]
12.5%/div 10µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0 10 20 30 40 50 60 70 80 90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

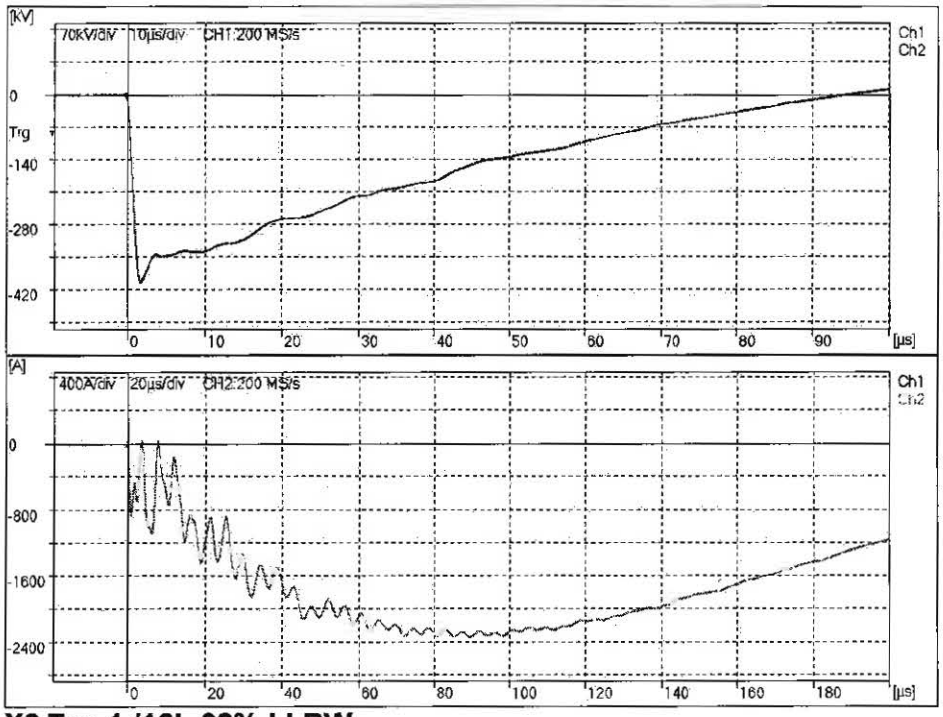

[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

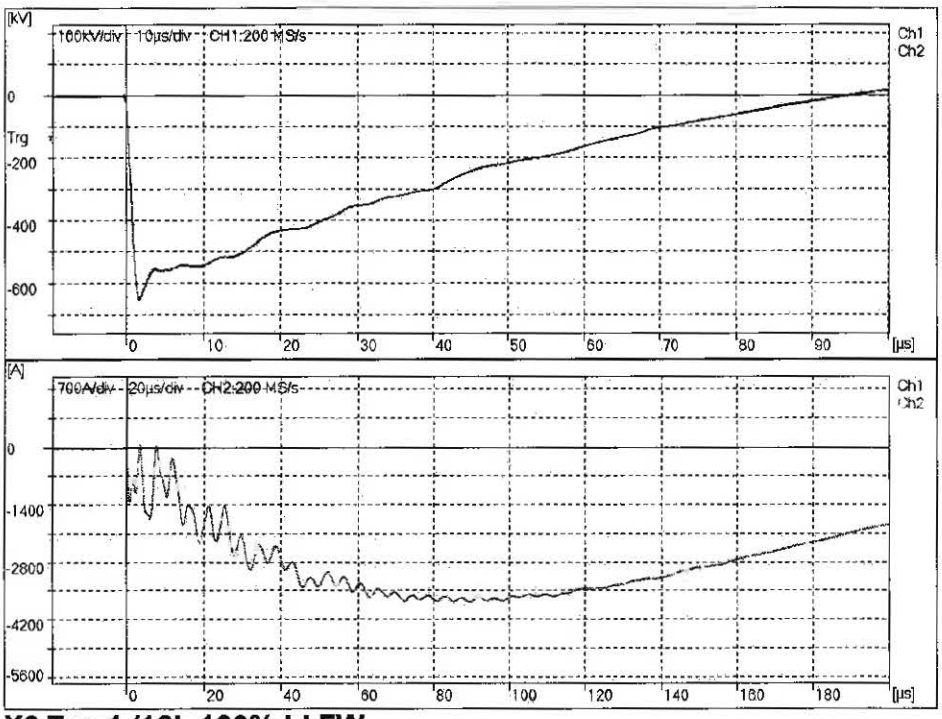
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: X2
Up = -404.2 kV
T1 = 1.369 μs
T2 = 34.50 μs
Ch2:
X1+X3+HV+H0X0
+Ip = 49.64 A
-Ip = -2345 A

X2 Tap 1 /16L 62% LI RW



No = 2
Ch1: X2
Up = -649.6 kV
T1 = 1.378 μs
T2 = 34.68 μs
Ch2:
X1+X3+HV+H0X0
+Ip = 79.98 A
-Ip = -3784 A

X2 Tap 1 /16L 100% LI FW

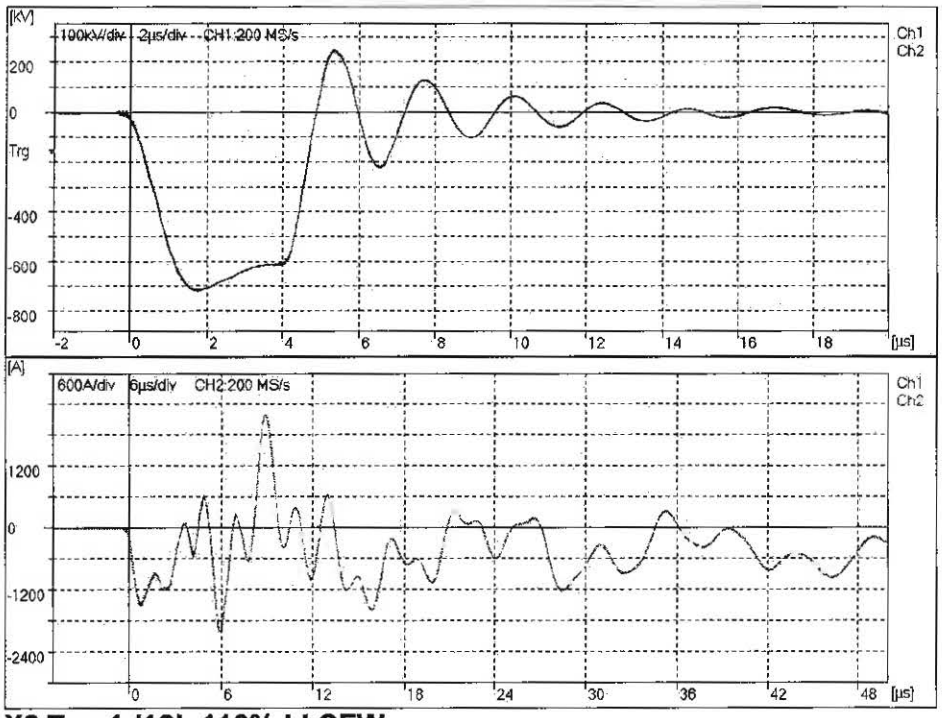
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

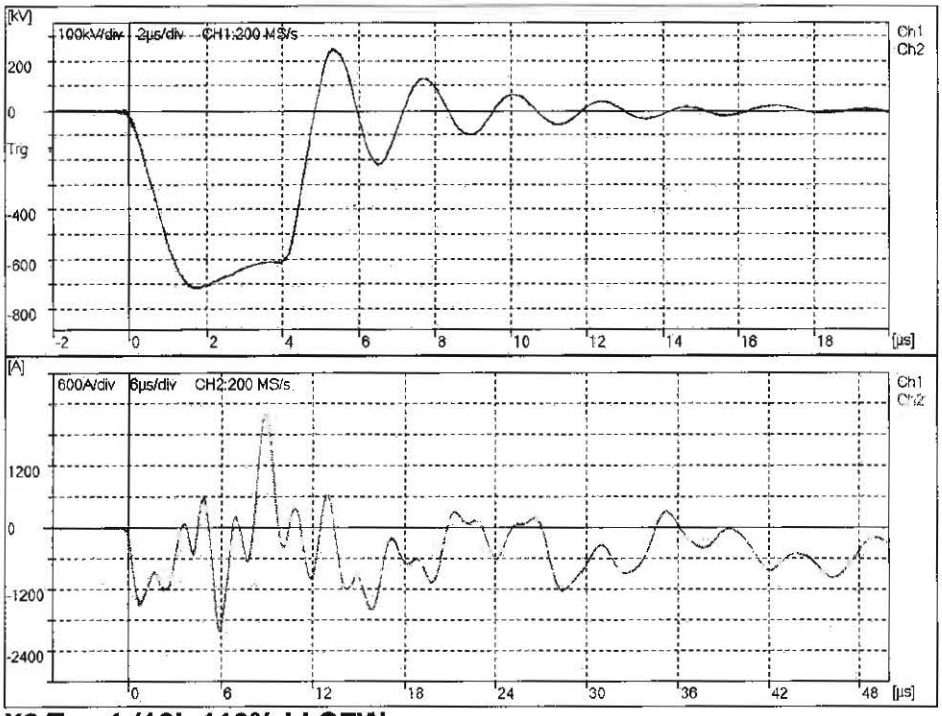
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: X2
Up = -715.5 kV
T1 = 1.389 μs
Tc = 4.045 μs
Ch2:
X1+X3+HV+H0X0
+Ip = 2199 A
-Ip = -2017 A

X2 Tap 1 /16L 110% LI CFW



No = 4
Ch1: X2
Up = -714.3 kV
T1 = 1.381 μs
Tc = 4.105 μs
Ch2:
X1+X3+HV+H0X0
+Ip = 2192 A
-Ip = -2013 A

X2 Tap 1 /16L 110% LI CFW

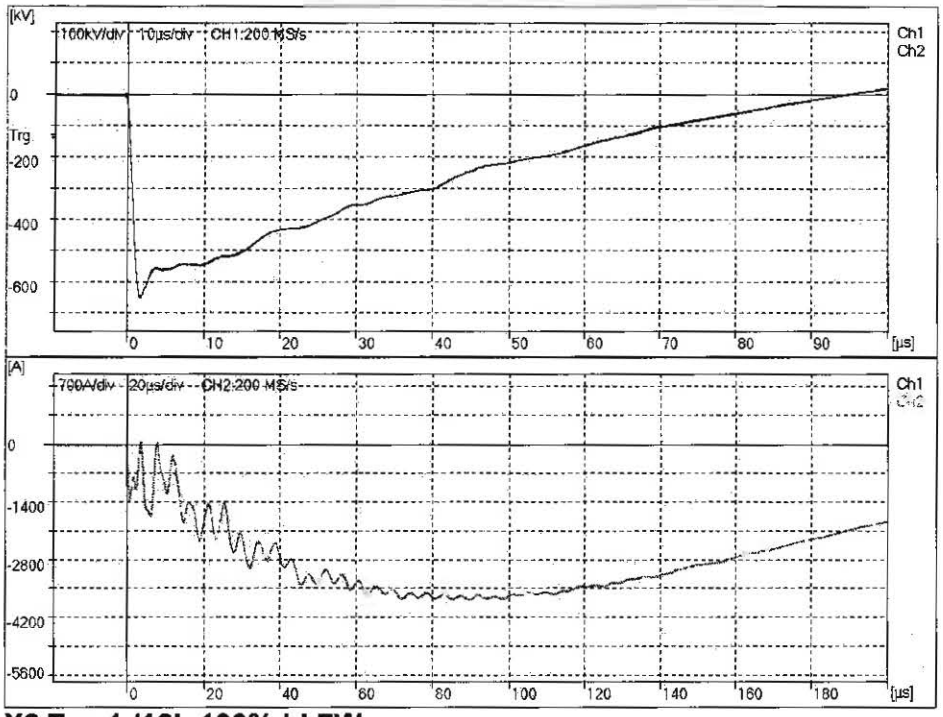
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

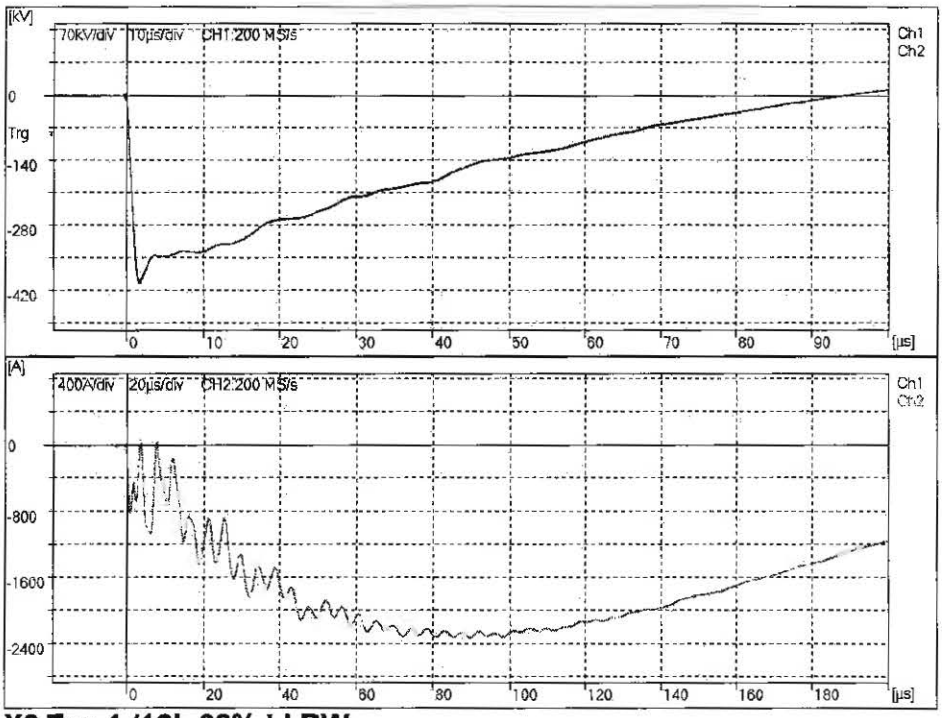
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: X2
Up = -650.2 kV
T1 = 1.383 µs
T2 = 34.62 µs
Ch2:
X1+X3+HV+H0X0
+Ip = 75.78 A
-Ip = -3784 A

X2 Tap 1 /16L 100% LI FW

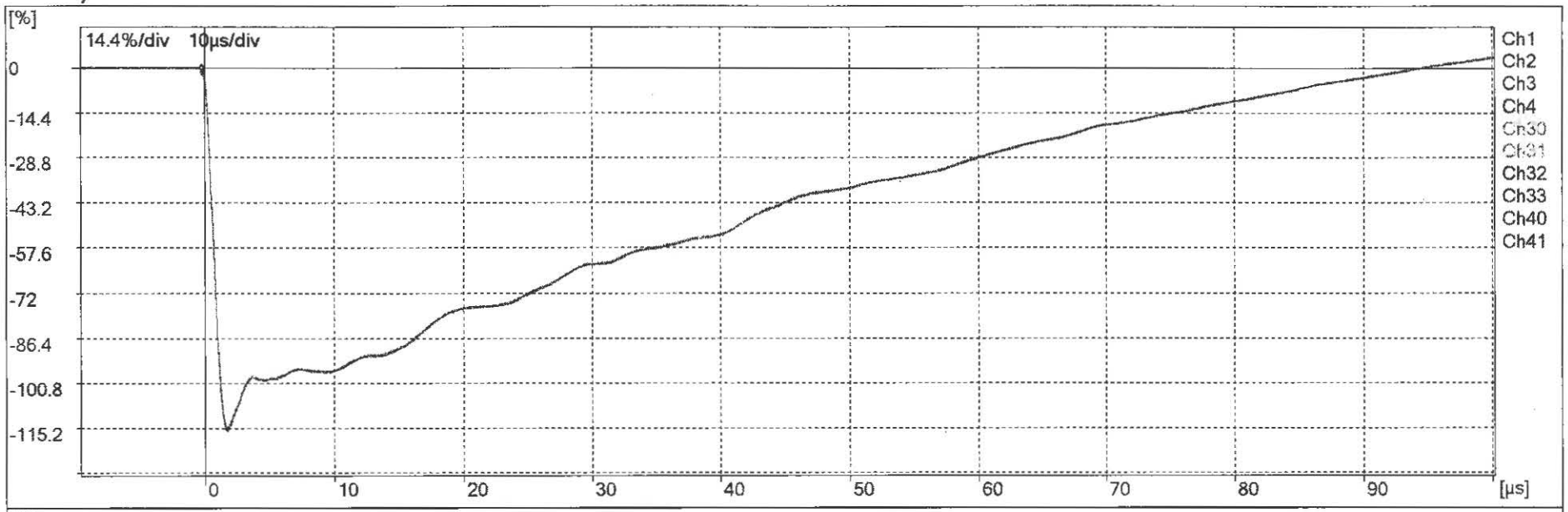


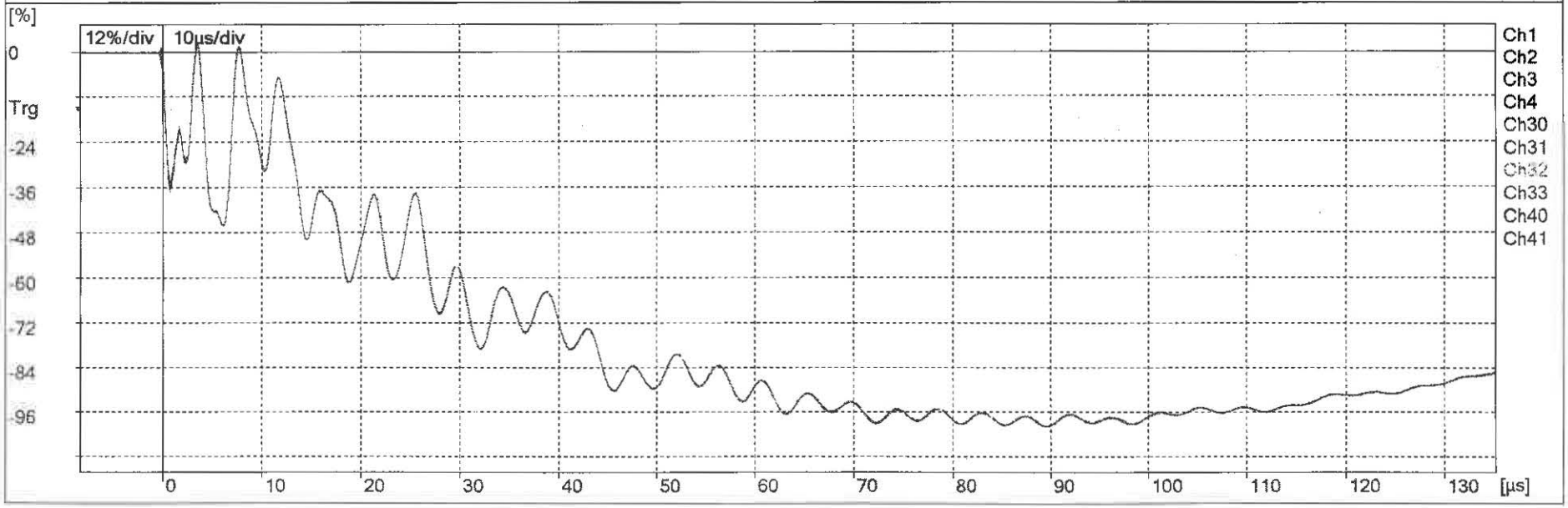
No = 6
Ch1: X2
Up = -402.3 kV
T1 = 1.367 µs
T2 = 34.57 µs
Ch2:
X1+X3+HV+H0X0
+Ip = 50.68 A
-Ip = -2336 A

X2 Tap 1 /16L 62% LI RW

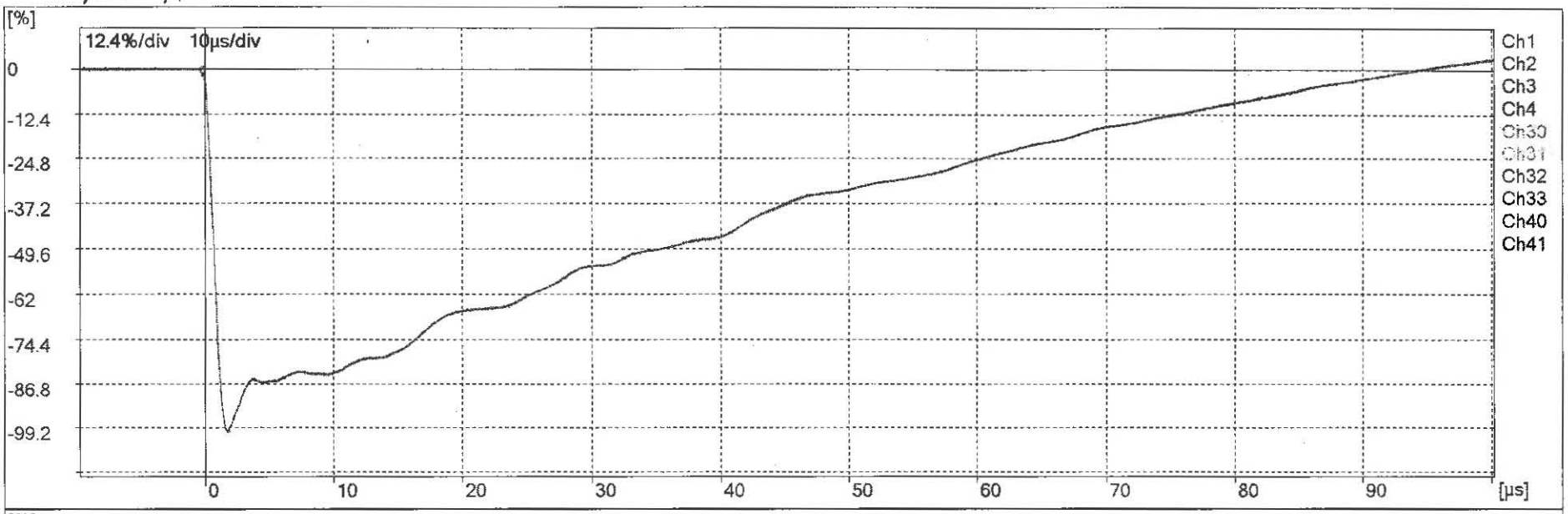
Date of test : 2/24/2013	Tested by : C. S. Ha

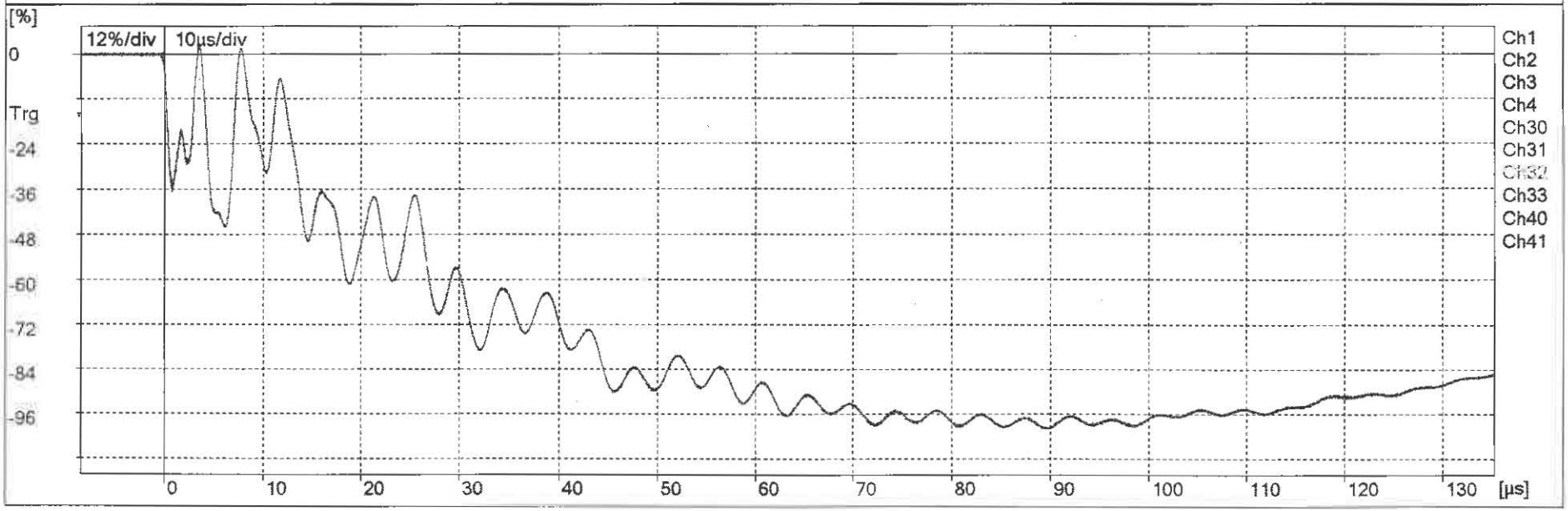
X2 R.FW – R.FW


[%]
14.4%/div 10µs/div
0
-14.4
-28.8
-43.2
-57.6
-72
-86.4
-100.8
-115.2
0 10 20 30 40 50 60 70 80 90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

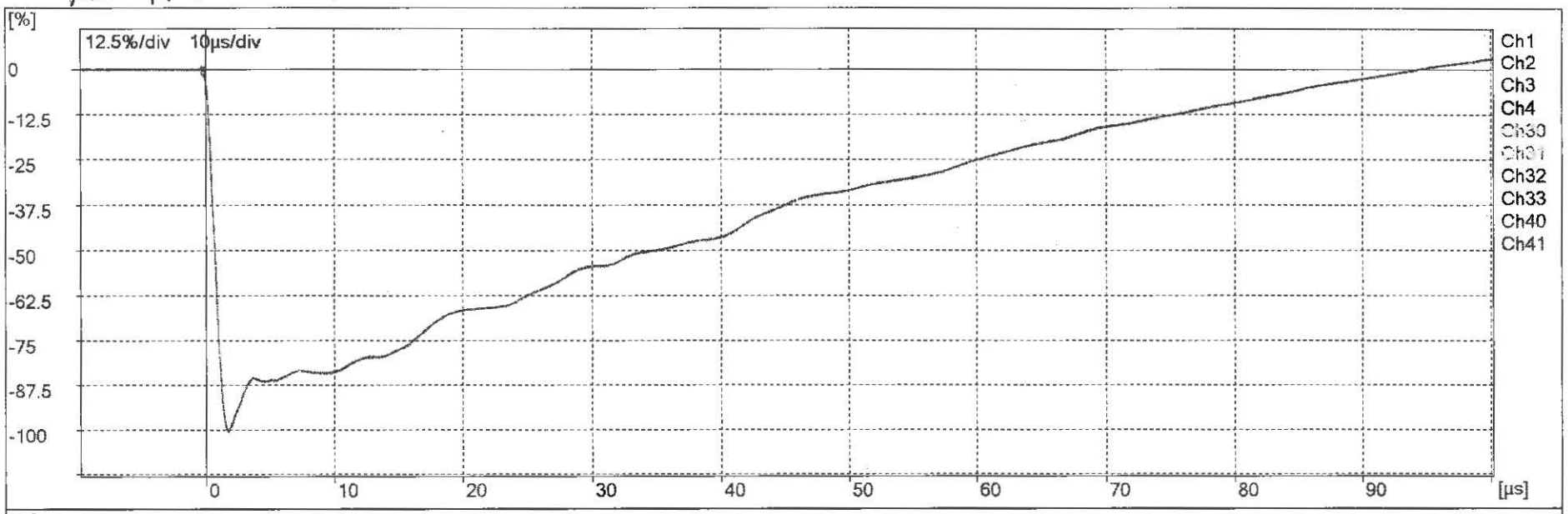

[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

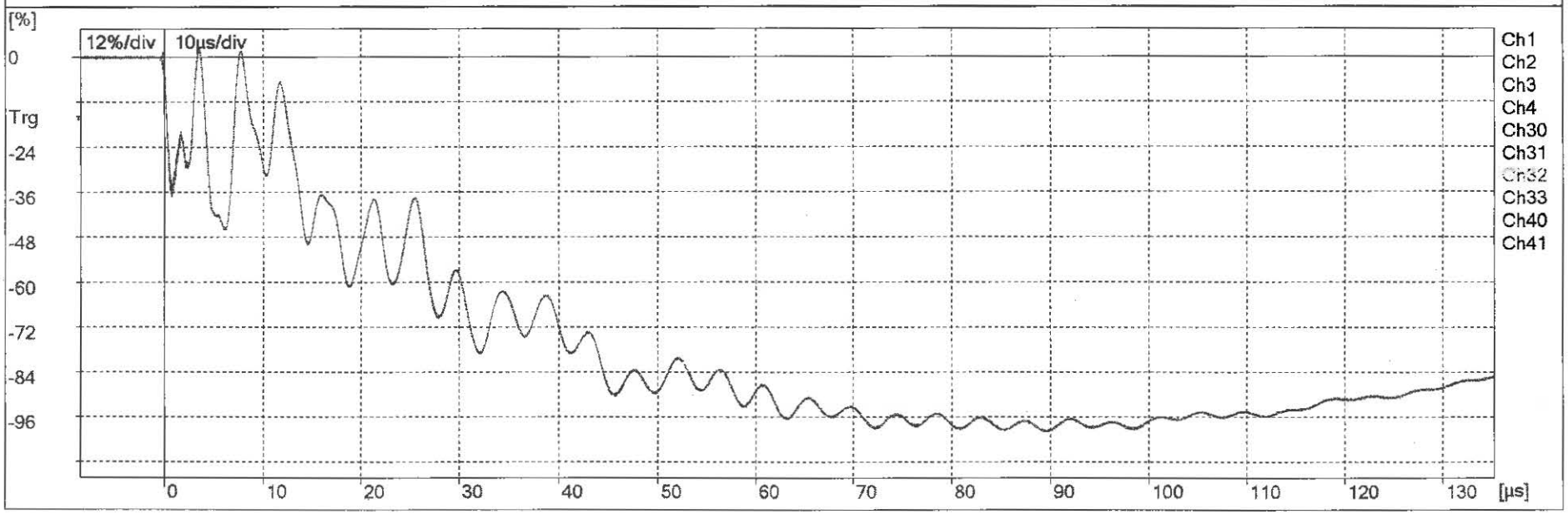
X2 FIW – FIW


[%]
12.4%/div 10µs/div
0
-12.4
-24.8
-37.2
-49.6
-62
-74.4
-86.8
-99.2
0 10 20 30 40 50 60 70 80 90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

X2 R.FW - FW


[%]
12.5%/div 10µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0 10 20 30 40 50 60 70 80 90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

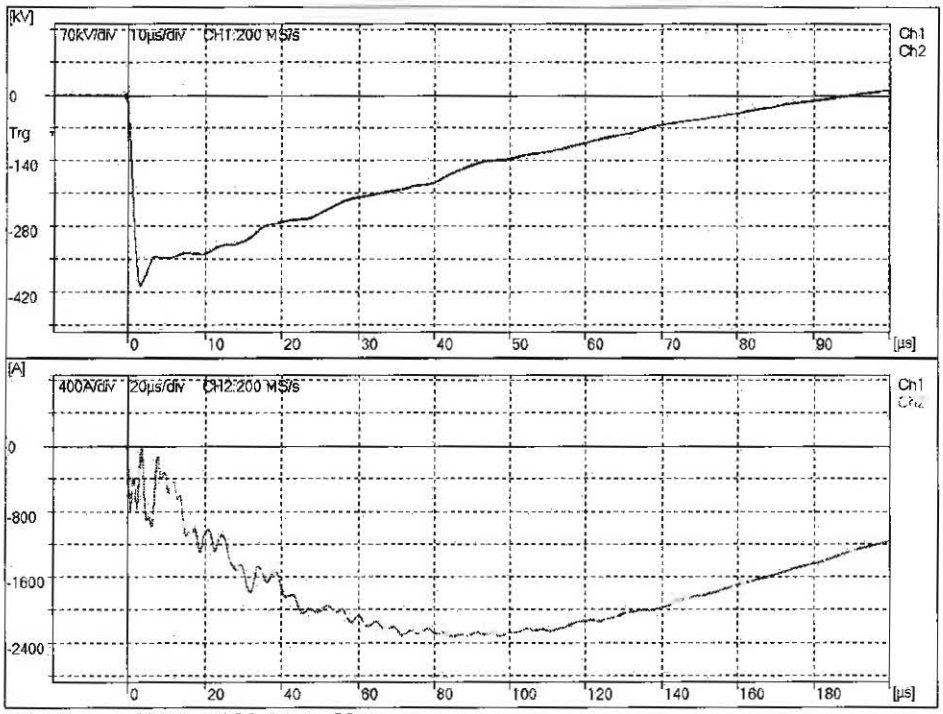

[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

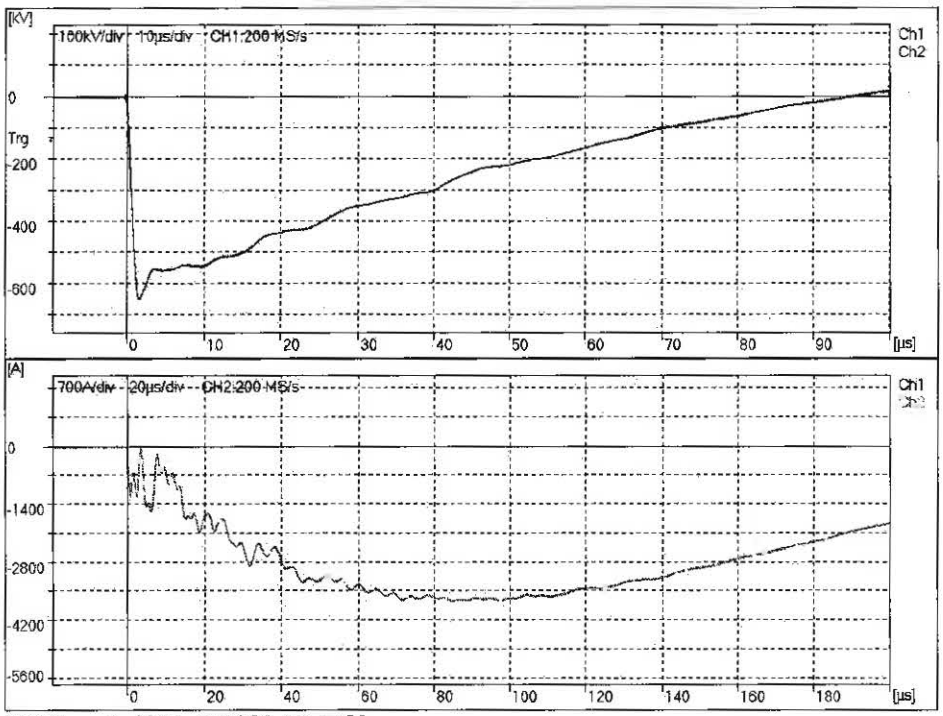
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: X3
Up = -404.0 kV
T1 = 1.310 µs
T2 = 35.22 µs
Ch2:
X1+X2+HV+H0X0
+Ip = 34.05 A
-Ip = -2328 A

X3 Tap 1 /16L 62% LI RW



No = 2
Ch1: X3
Up = -649.8 kV
T1 = 1.320 µs
T2 = 35.31 µs
Ch2:
X1+X2+HV+H0X0
+Ip = 10.69 A
-Ip = -3758 A

X3 Tap 1 /16L 100% LI FW

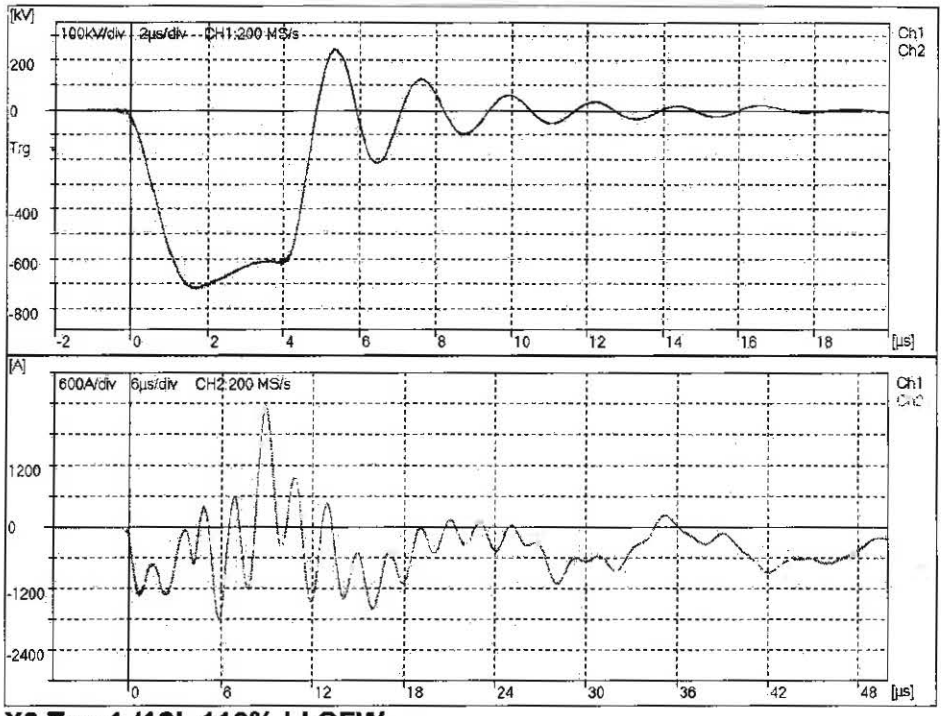
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

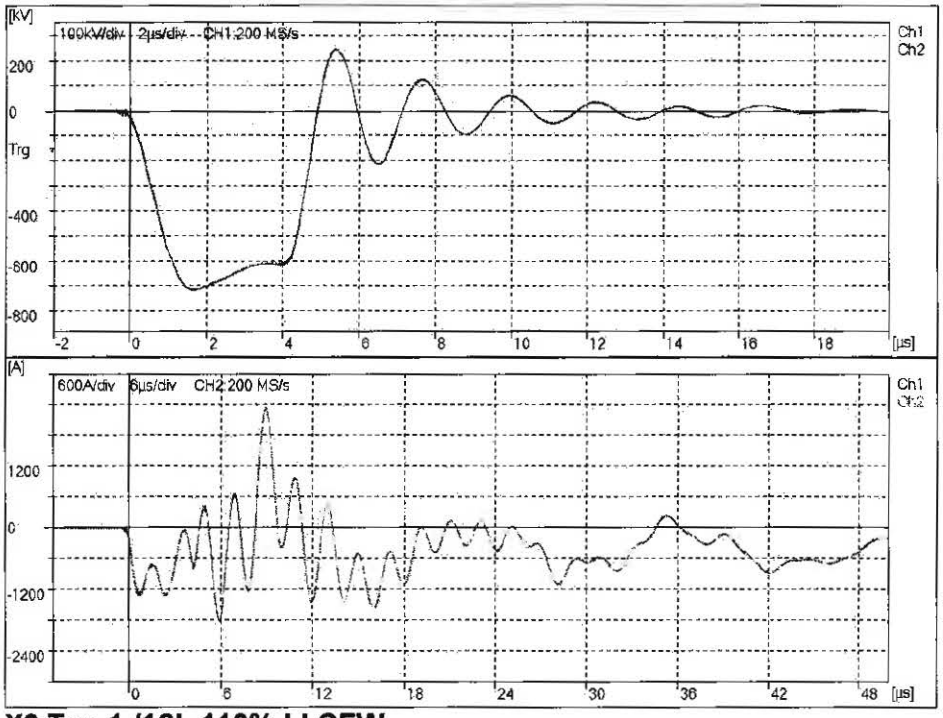
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: X3
Up = -715.1 kV
T1 = 1.326 µs
Tc = 4.116 µs
Ch2:
X1+X2+HV+H0X0
+Ip = 2352 A
-Ip = -1816 A

X3 Tap 1 /16L 110% LI CFW



No = 4
Ch1: X3
Up = -714.0 kV
T1 = 1.323 µs
Tc = 4.180 µs
Ch2:
X1+X2+HV+H0X0
+Ip = 2342 A
-Ip = -1822 A

X3 Tap 1 /16L 110% LI CFW

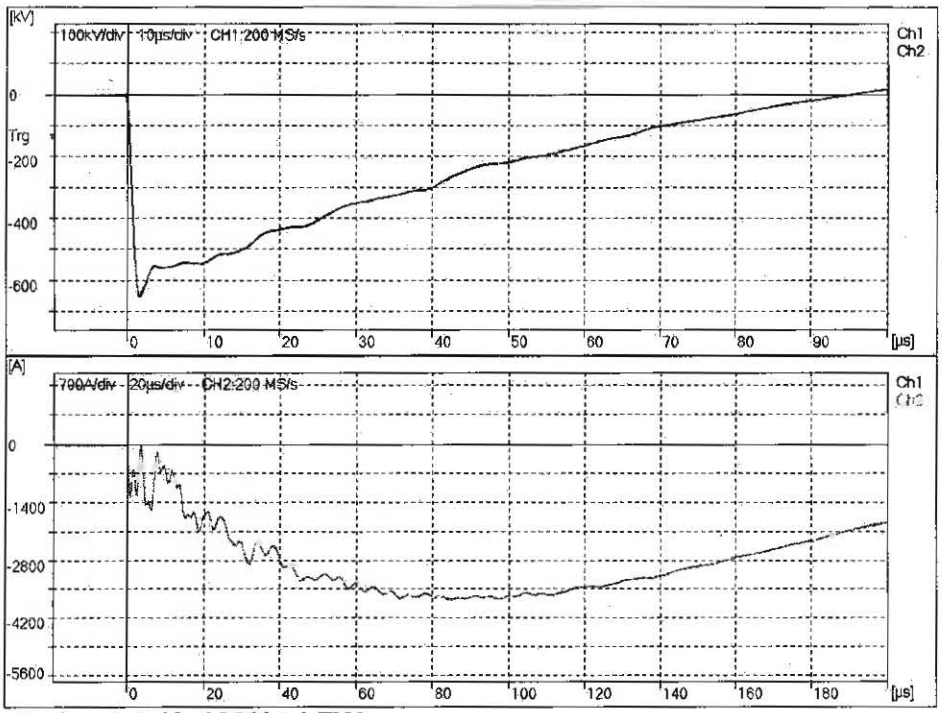
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning Impulses Test Report

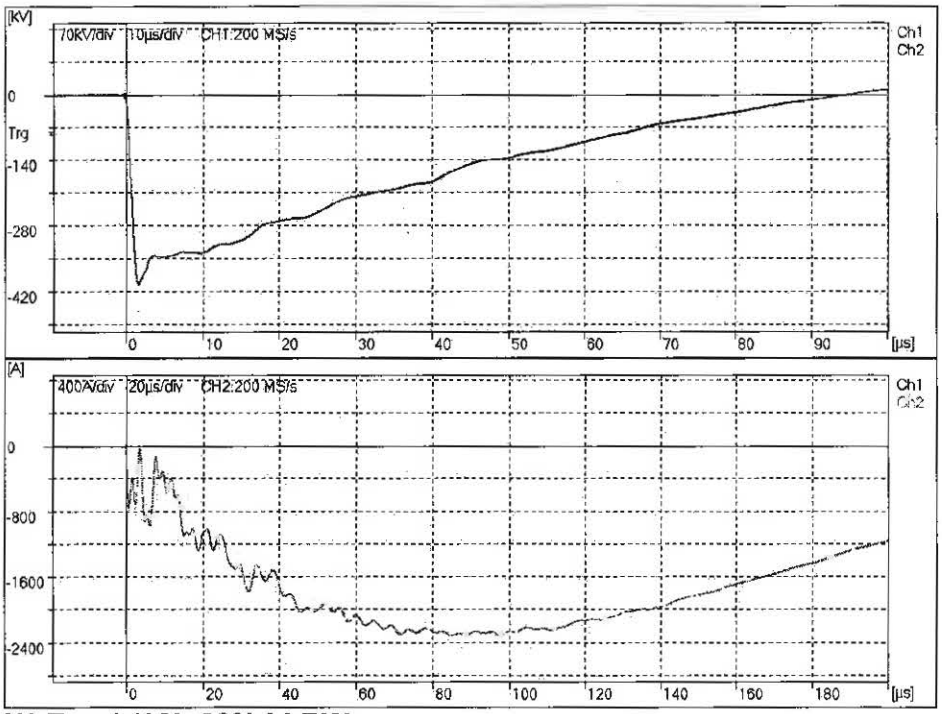
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: X3
Up = -649.6 kV
T1 = 1.319 µs
T2 = 35.32 µs
Ch2:
X1+X2+HV+H0X0
+Ip = 8.592 A
-Ip = -3758 A

X3 Tap 1 /16L 100% LI FW

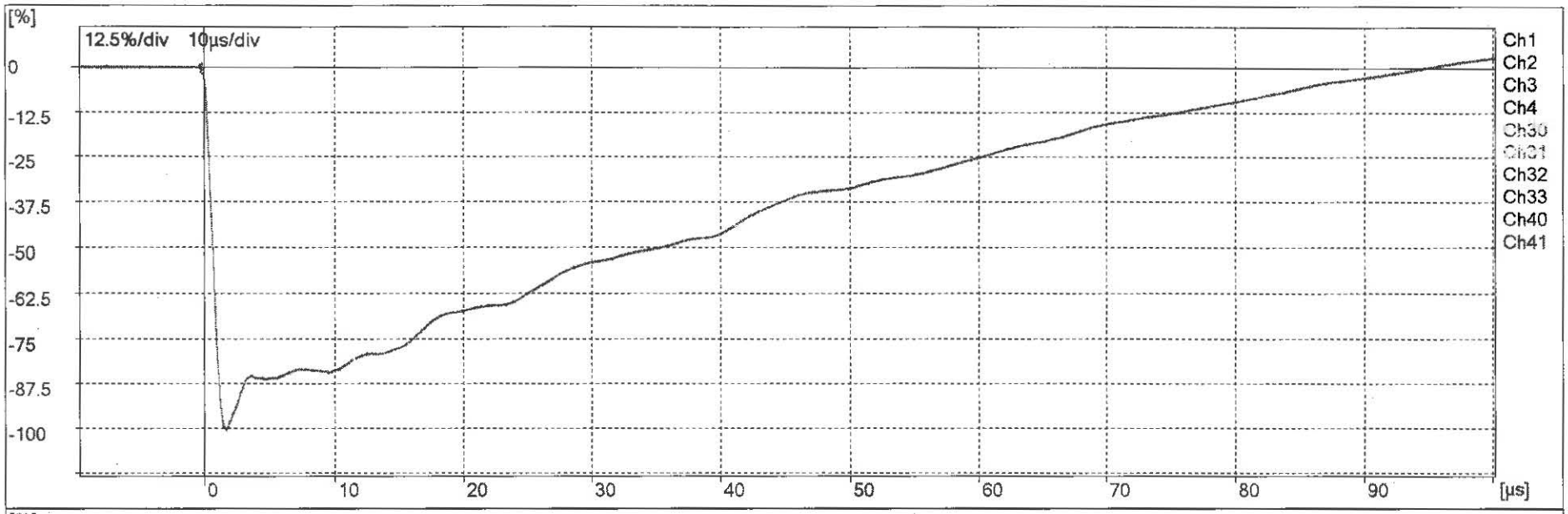


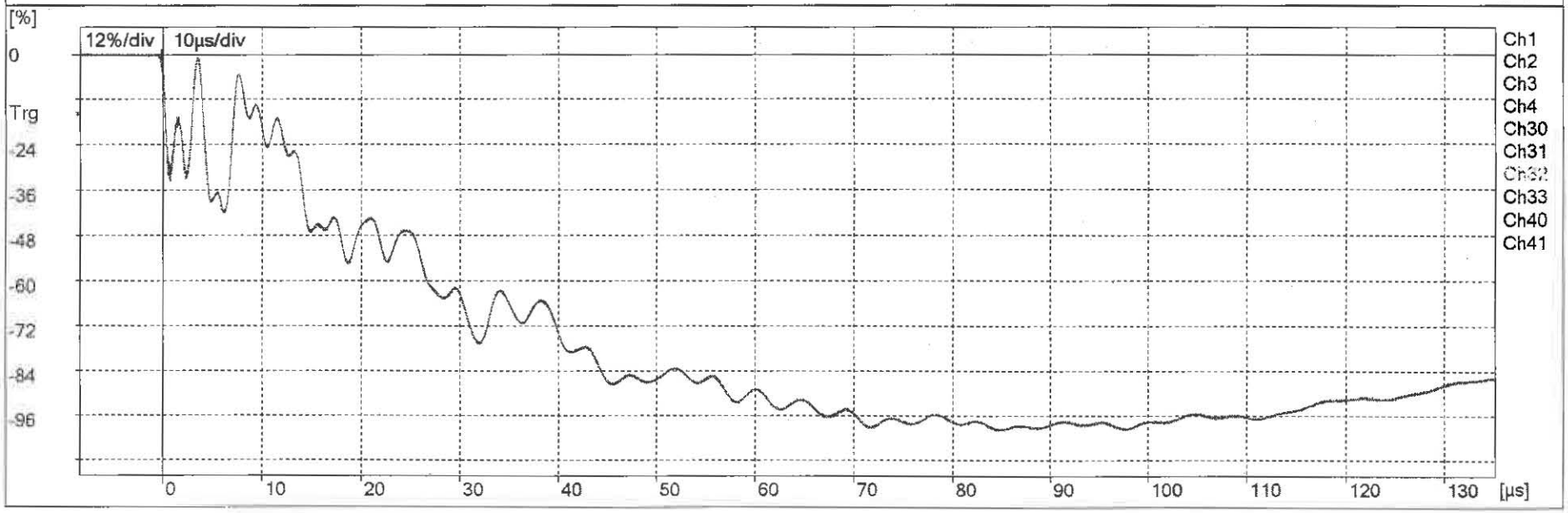
No = 6
Ch1: X3
Up = -402.4 kV
T1 = 1.311 µs
T2 = 35.24 µs
Ch2:
X1+X2+HV+H0X0
+Ip = 14.31 A
-Ip = -2317 A

X3 Tap 1 /16L 62% LI RW

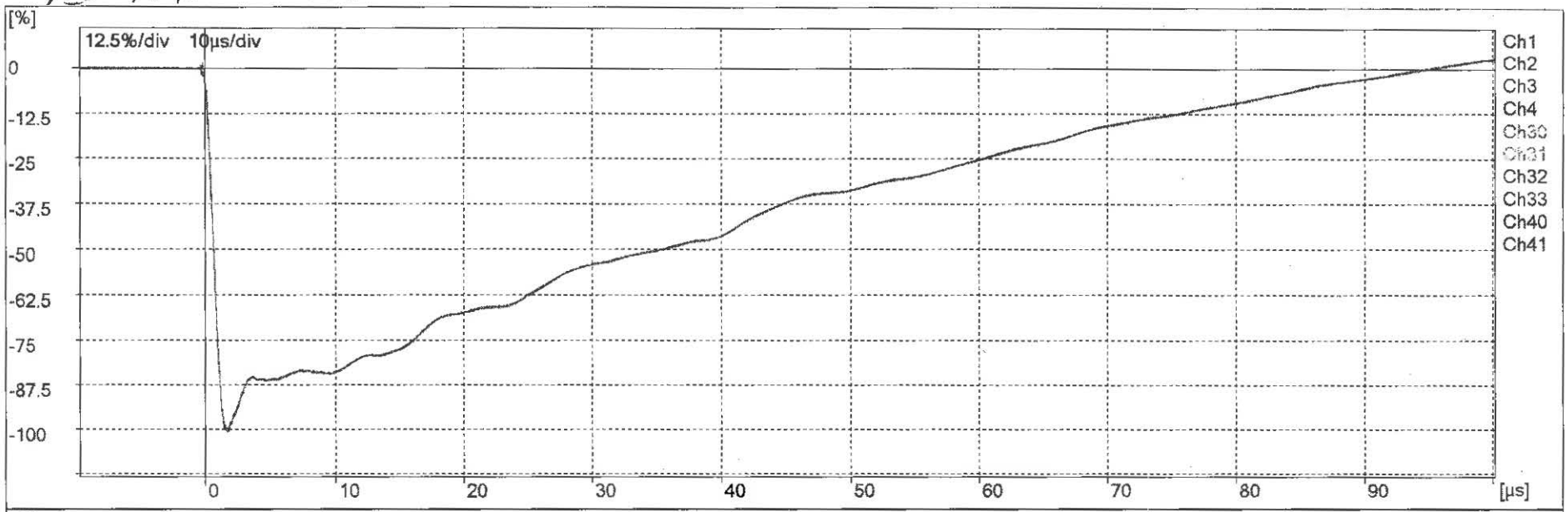
Date of test : 2/24/2013	Tested by : C. S. Ha

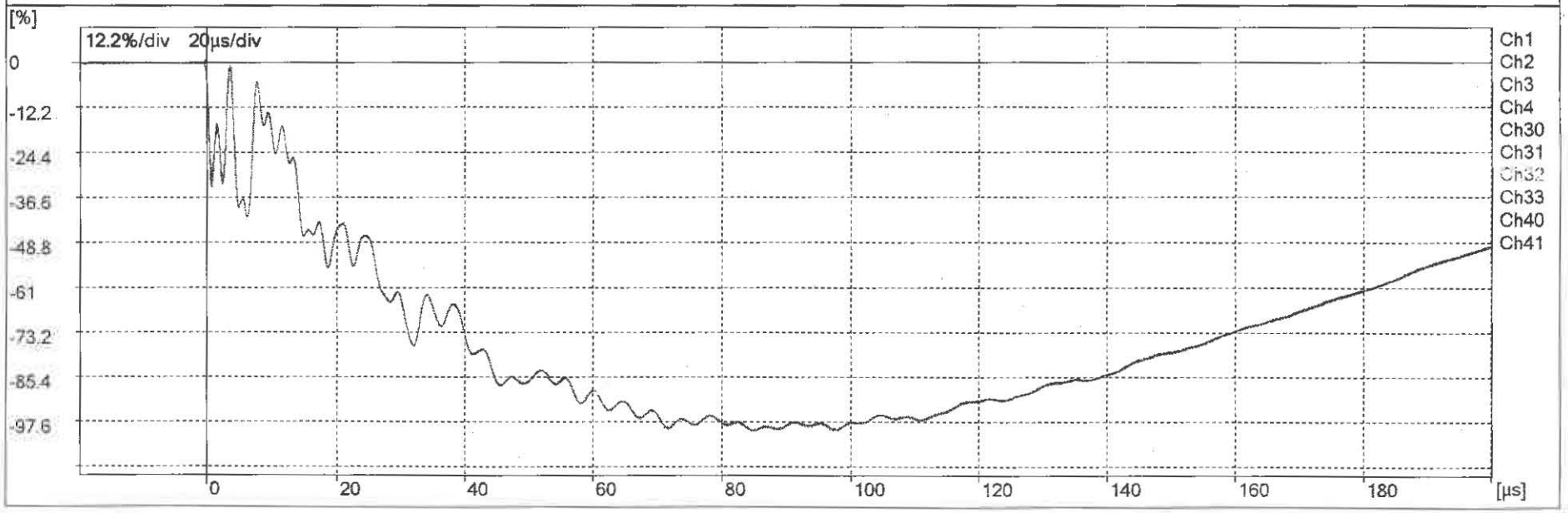
X3 R.FW - FW


[%]
12.5%/div 10µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0 10 20 30 40 50 60 70 80 90 [µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

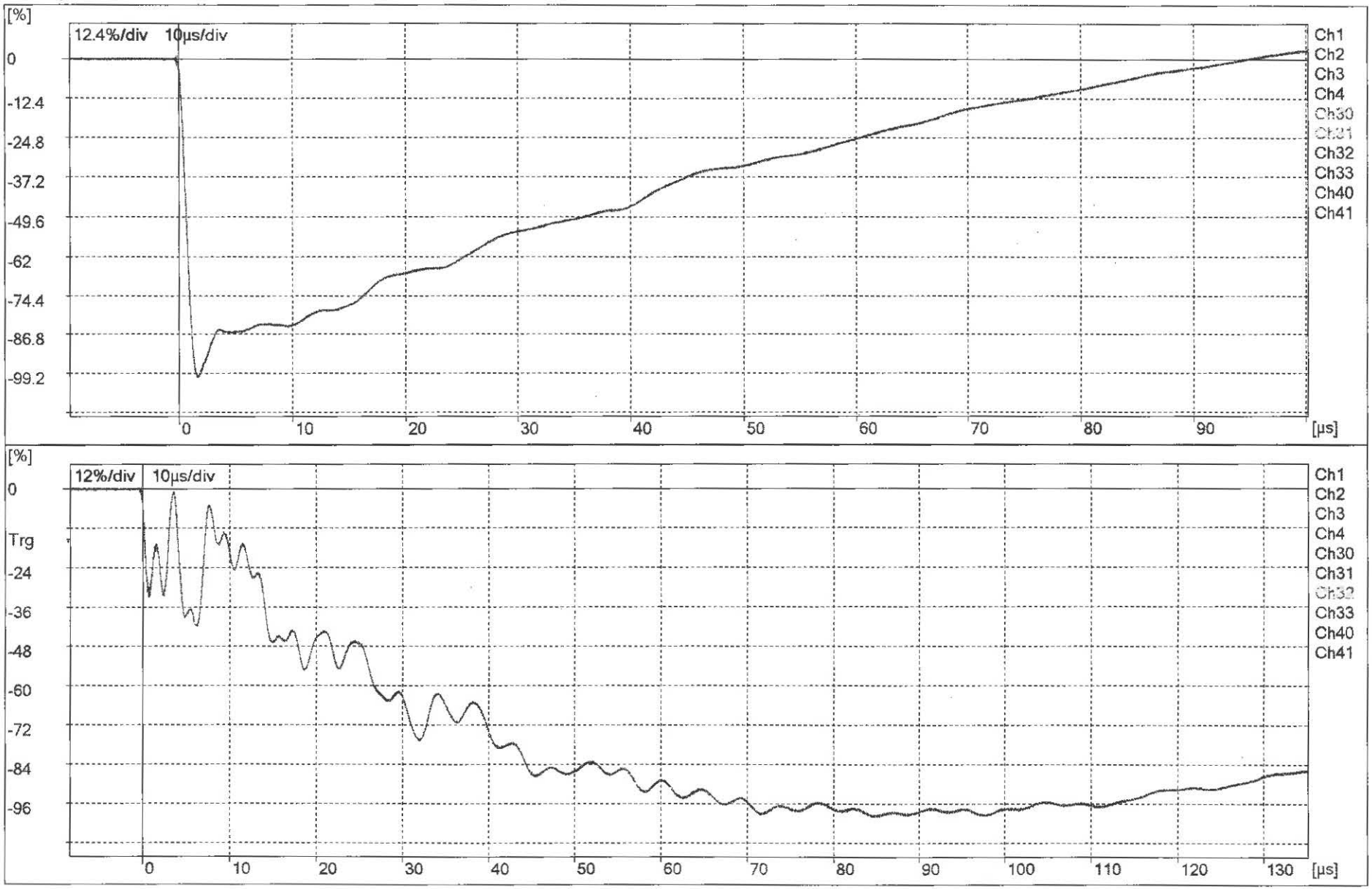

[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130 [µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

X3 R.FW – R.FW


[%]
12.5%/div 10µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12.2%/div 20µs/div
0
-12.2
-24.4
-36.6
-48.8
-61
-73.2
-85.4
-97.6
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

X3 FW - FW'

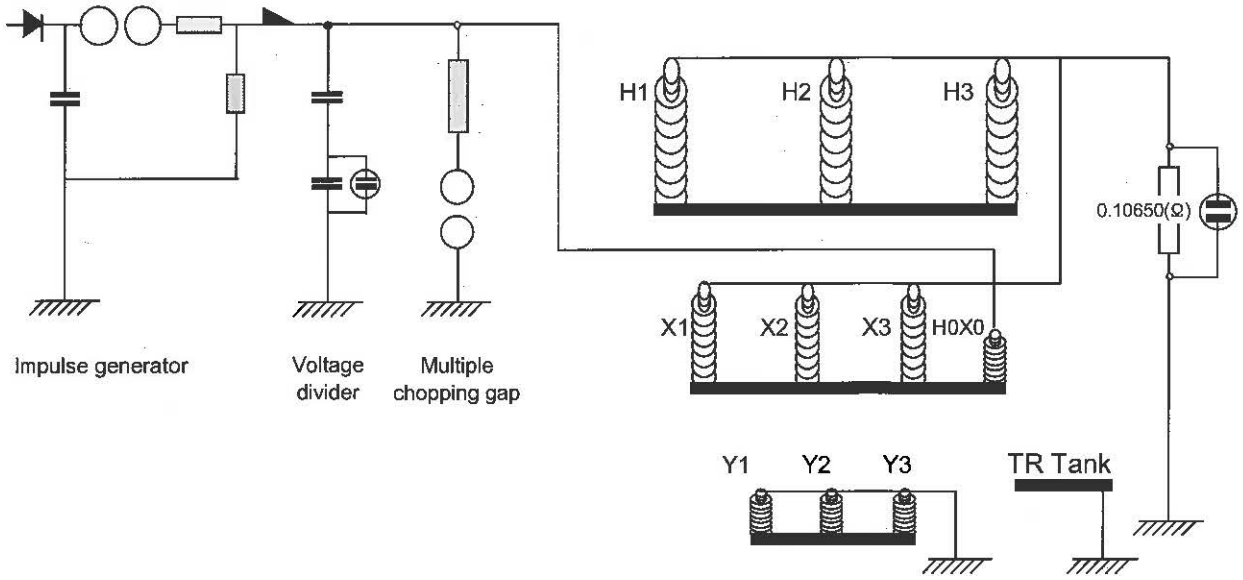

[%]
12.4%/div 10µs/div
0
-12.4
-24.8
-37.2
-49.6
-62
-74.4
-86.8
-99.2
0 10 20 30 40 50 60 70 80 90 [µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41
[%]
12%/div 10µs/div
0
Trg
-24
-36
-48
-60
-72
-84
-96
0 10 20 30 40 50 60 70 80 90 100 110 120 130 [µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning impulse voltage withstand test

Serial No.
20120871TKE001

Lightning impulse voltage test with N winding



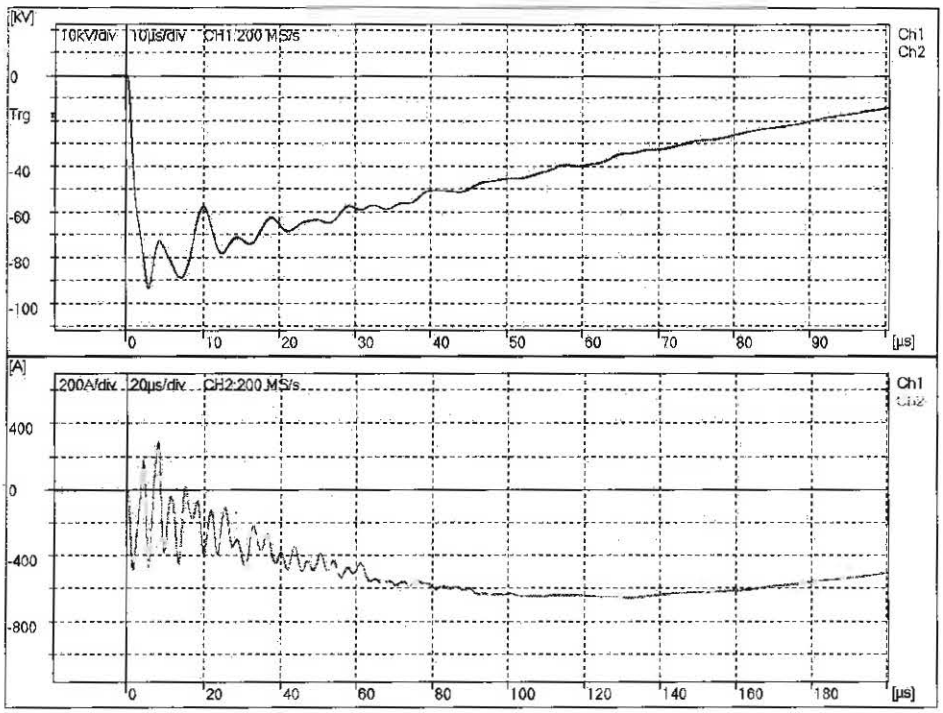
Date of Test : 2013. 02. 24	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

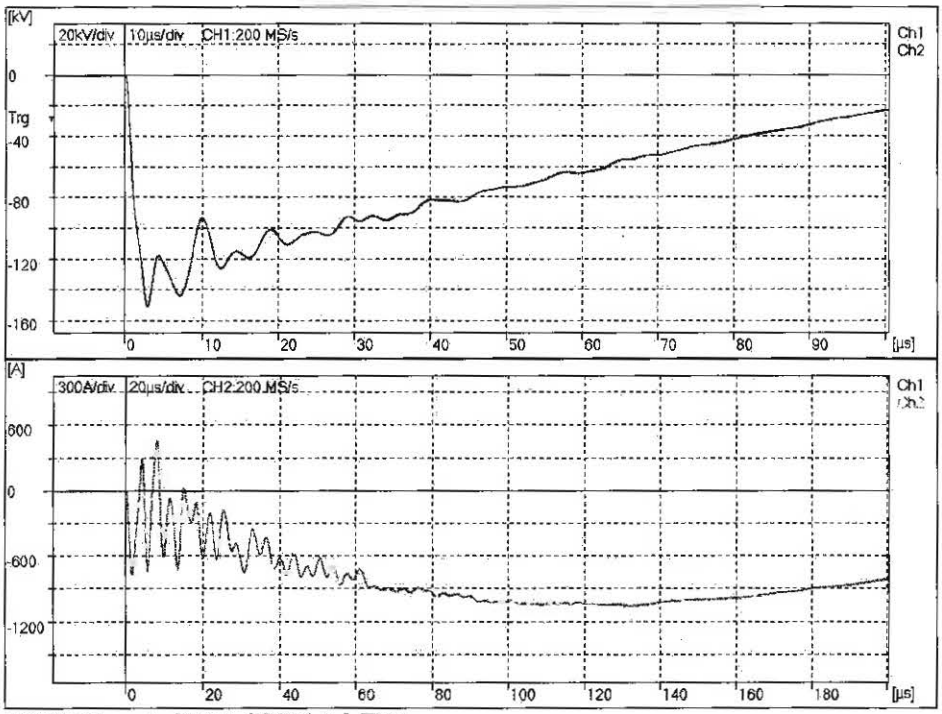
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: H0X0
Up = -93.24 kV
T1 = 2.777 μs
T2 = 47.57 μs
Ch2: HV+LV
+Ip = 289.6 A
-Ip = -657.4 A

H0X0 Tap 1 /16R 62% LI RW



No = 2
Ch1: H0X0
Up = -150.4 kV
T1 = 2.780 μs
T2 = 47.71 μs
Ch2: HV+LV
+Ip = 465.0 A
-Ip = -1059 A

H0X0 Tap 1 /16R 100% LI FW

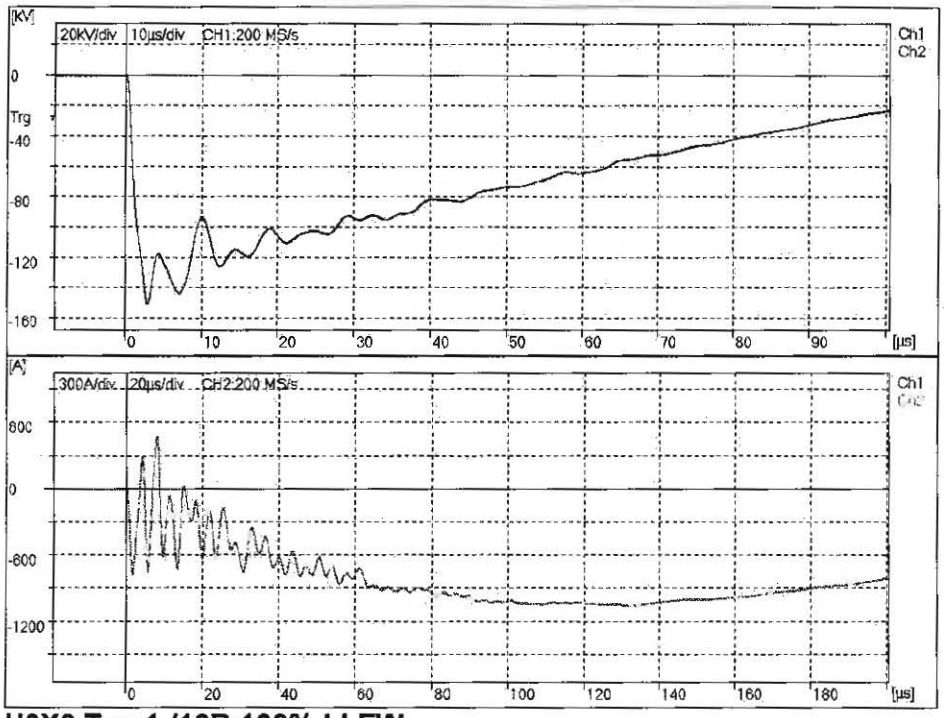
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

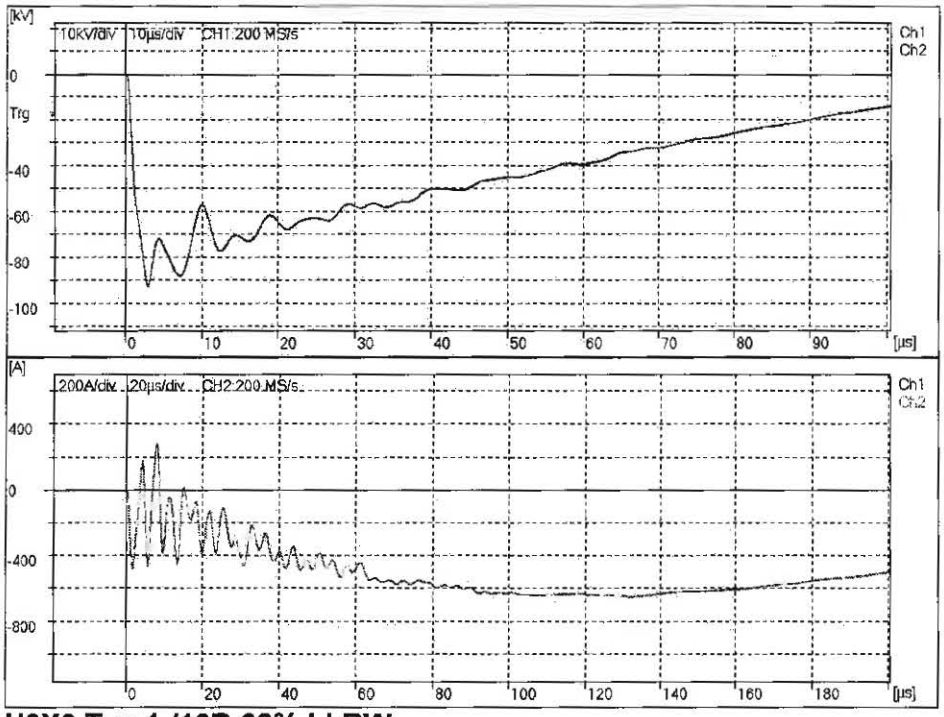
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: H0X0
Up = -150.7 kV
T1 = 2.782 μs
T2 = 47.57 μs
Ch2: HV+LV
+Ip = 470.2 A
-Ip = -1059 A

H0X0 Tap 1 /16R 100% LI FW

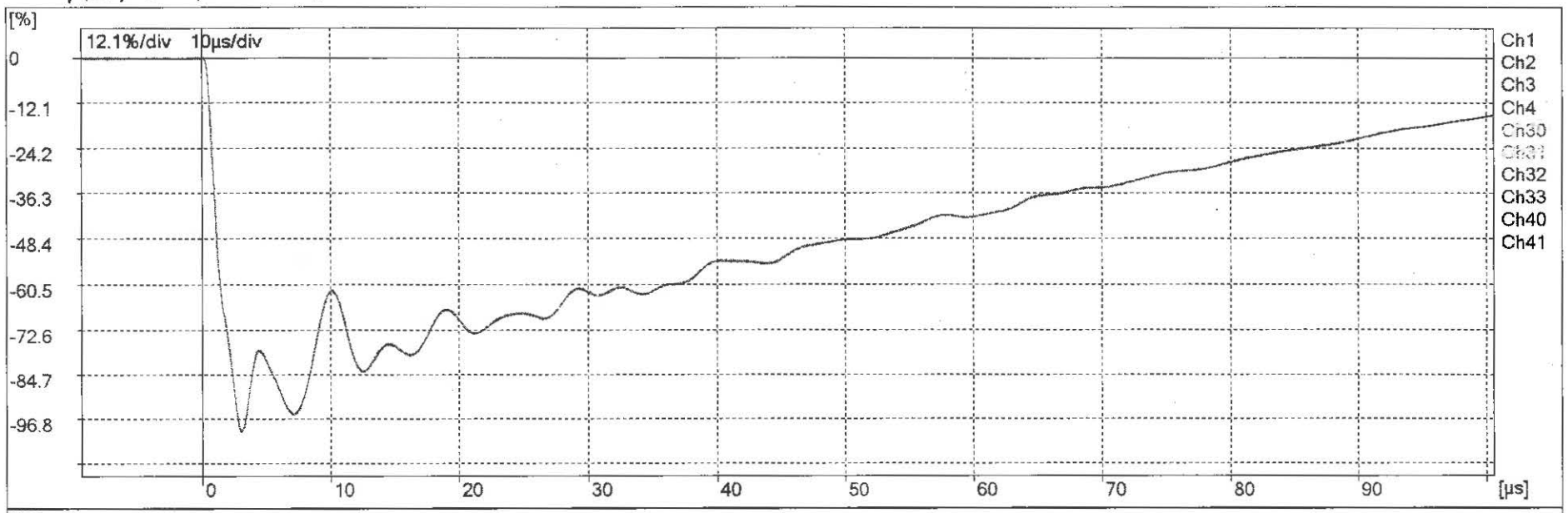


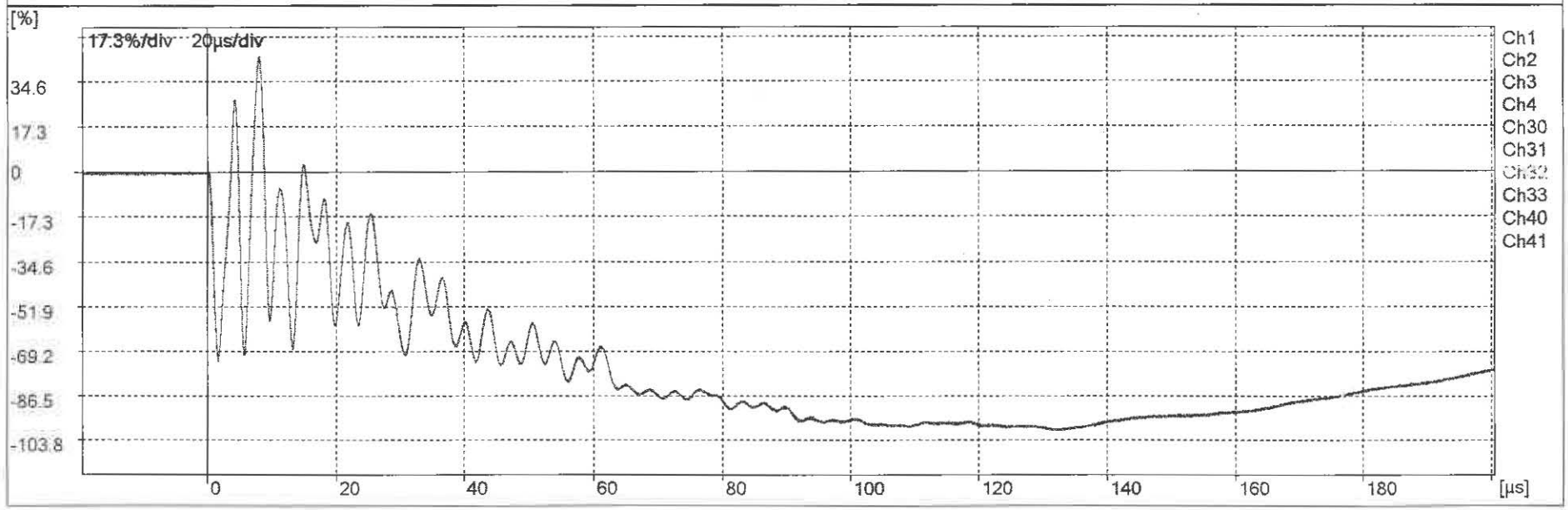
No = 4
Ch1: H0X0
Up = -92.33 kV
T1 = 2.777 μs
T2 = 47.53 μs
Ch2: HV+LV
+Ip = 289.1 A
-Ip = -651.1 A

H0X0 Tap 1 /16R 62% LI RW

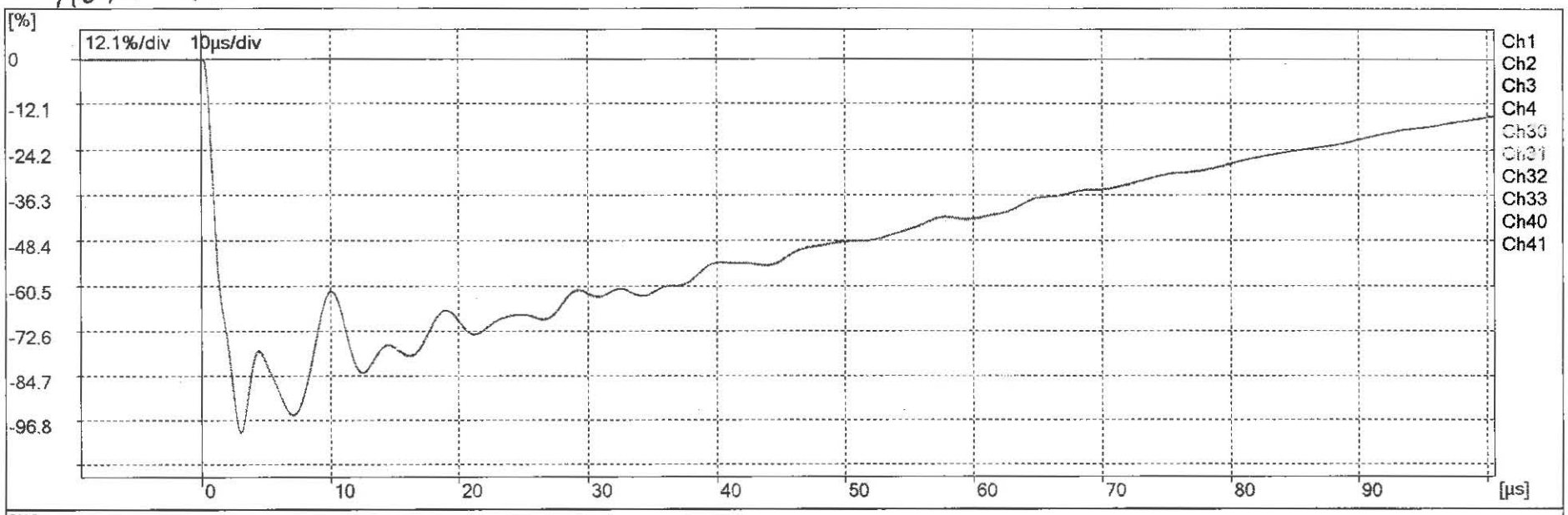
Date of test : 2/24/2013	Tested by : C. S. Ha

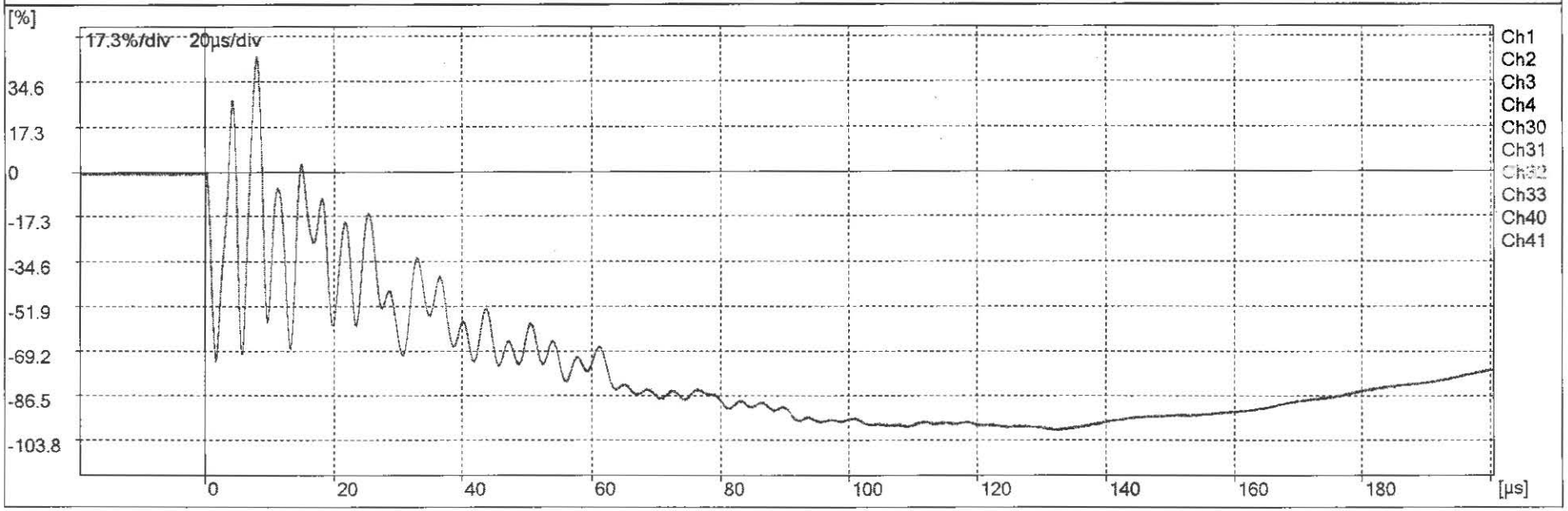
HoXo FW - FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

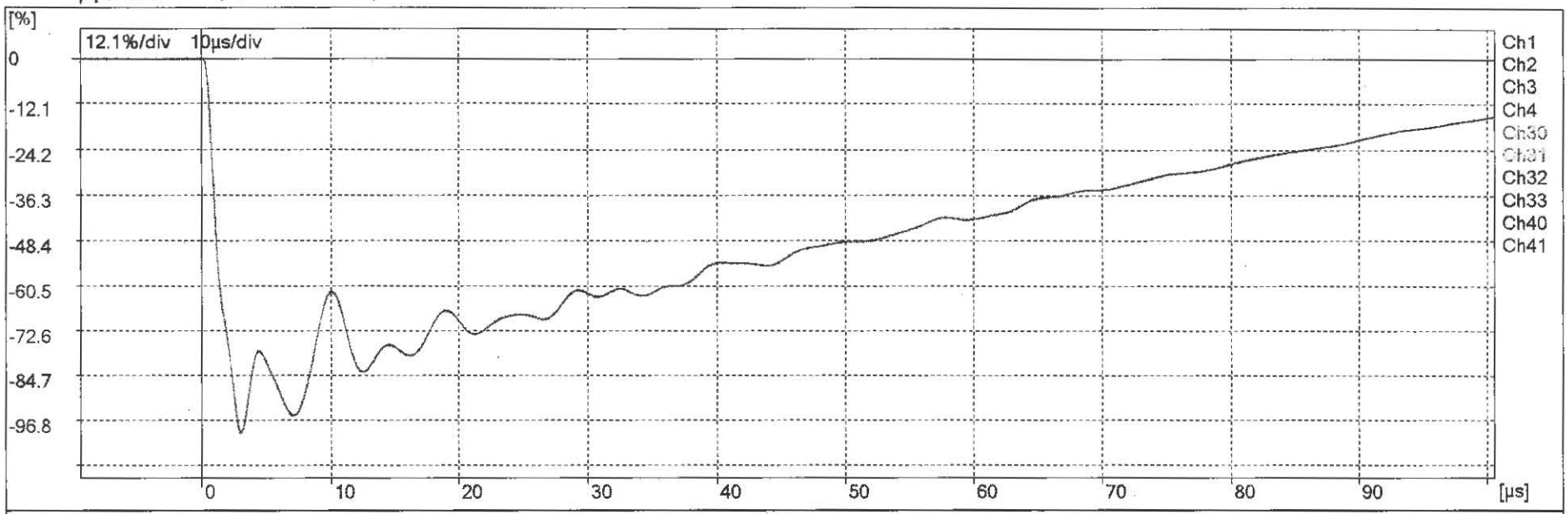

[%]
17.3%/div 20µs/div
34.6
17.3
0
-17.3
-34.6
-51.9
-69.2
-86.5
-103.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

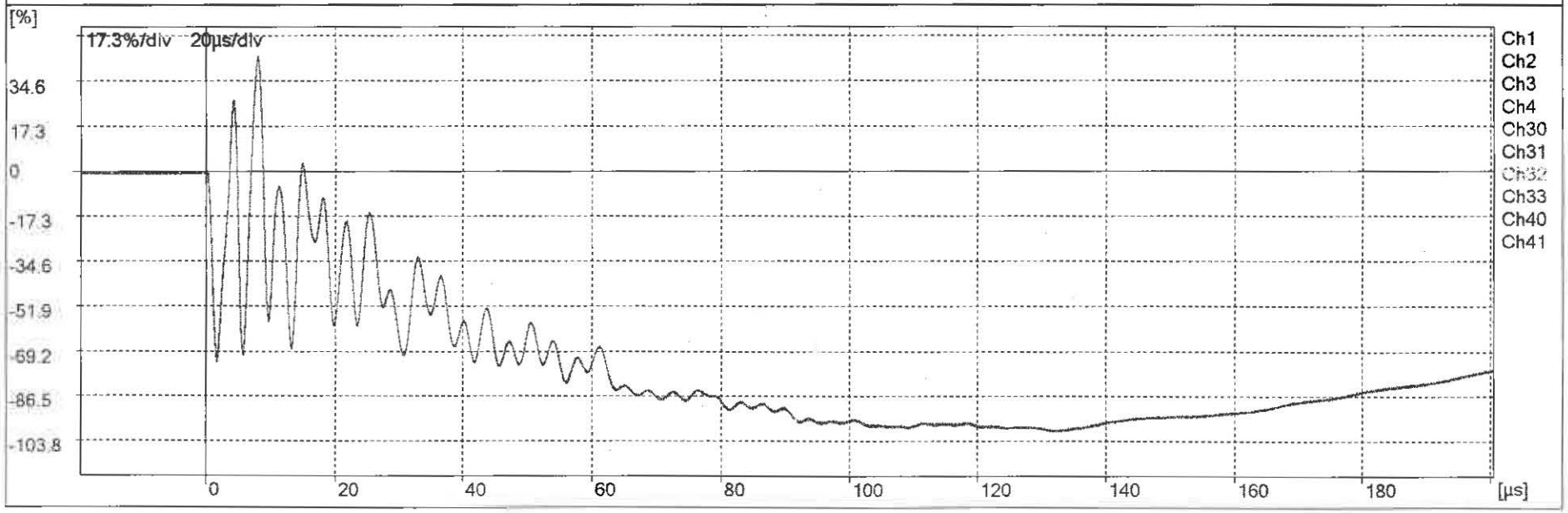
Hc Xo R.Fw – R.Fw


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
17.3%/div 20µs/div
34.6
17.3
0
-17.3
-34.6
-51.9
-69.2
-86.5
-103.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HoXo R.FW - FW


[%]
12.1%/div 10µs/div
0
-12.1
-24.2
-36.3
-48.4
-60.5
-72.6
-84.7
-96.8
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

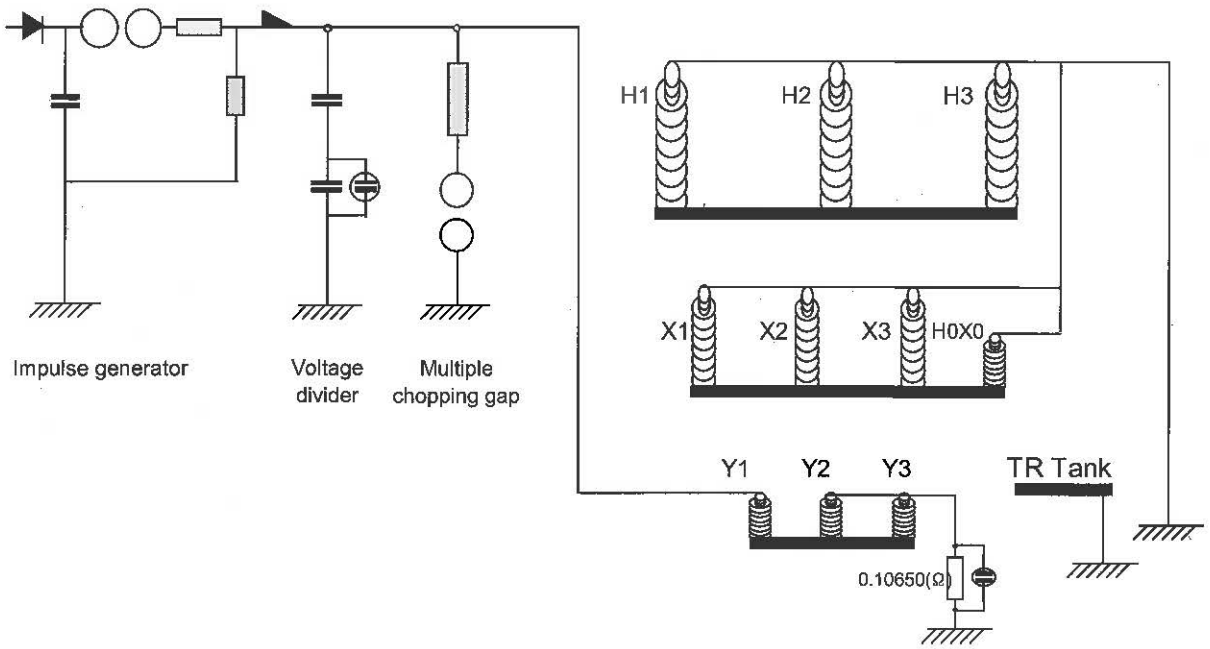

[%]
17.3%/div 20µs/div
34.6
17.3
0
-17.3
-34.6
-51.9
-69.2
-86.5
-103.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Lightning impulse voltage withstand test

Serial No.
20120871TKE001

Lightning impulse voltage test with TV winding



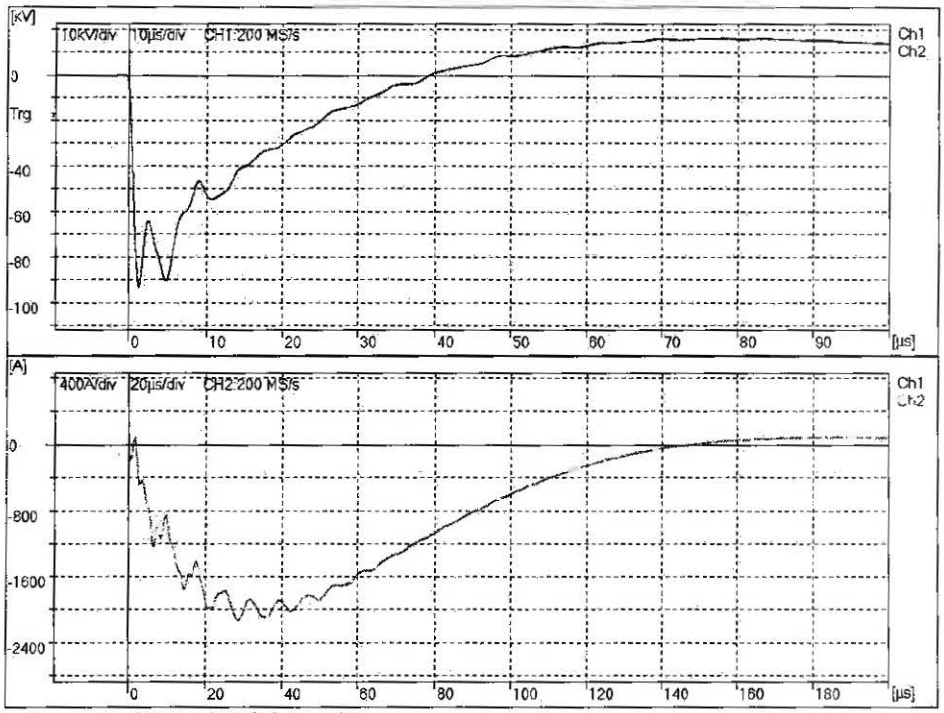
Date of Test : 2013. 02. 24	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO. LTD

Lightning Impulses Test Report

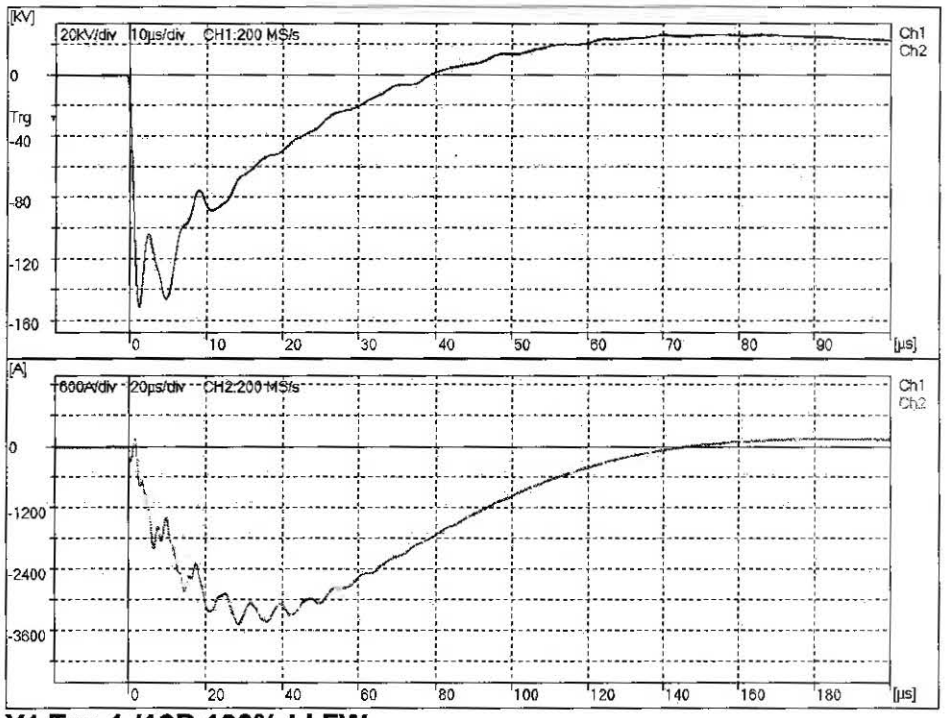
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: Y1
Up = -92.99 kV
T1 = 1.058 μs
T2 = 13.50 μs
Ch2: Y2+Y3
+Ip = 98.47 A
-Ip = -2130 A

Y1 Tap 1 /16R 62% LI RW



No = 2
Ch1: Y1
Up = -150.8 kV
T1 = 1.057 μs
T2 = 13.50 μs
Ch2: Y2+Y3
+Ip = 165.1 A
-Ip = -3476 A

Y1 Tap 1 /16R 100% LI FW

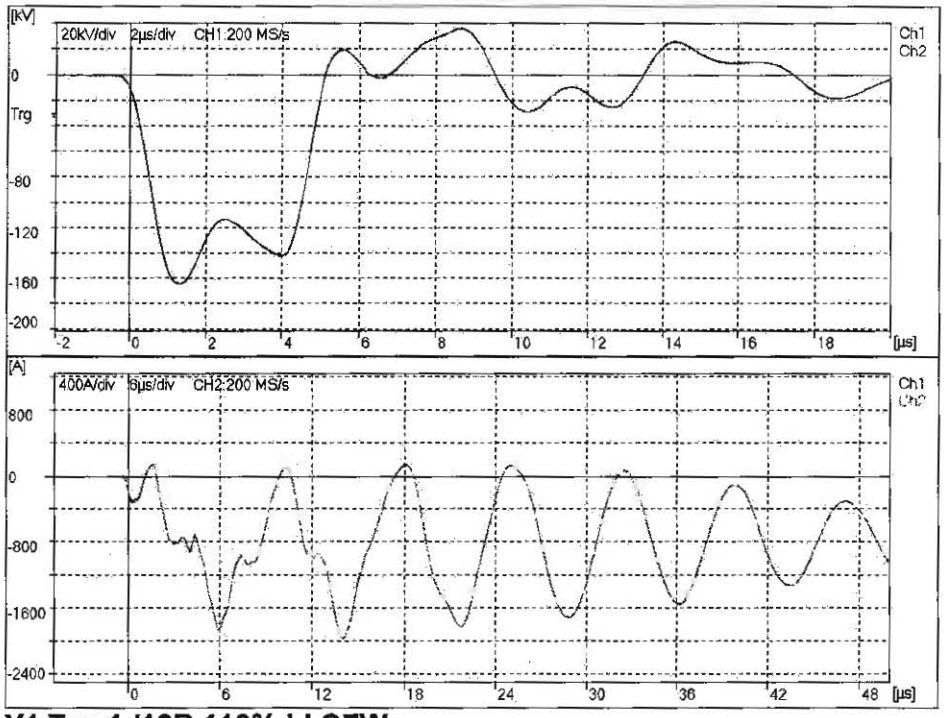
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

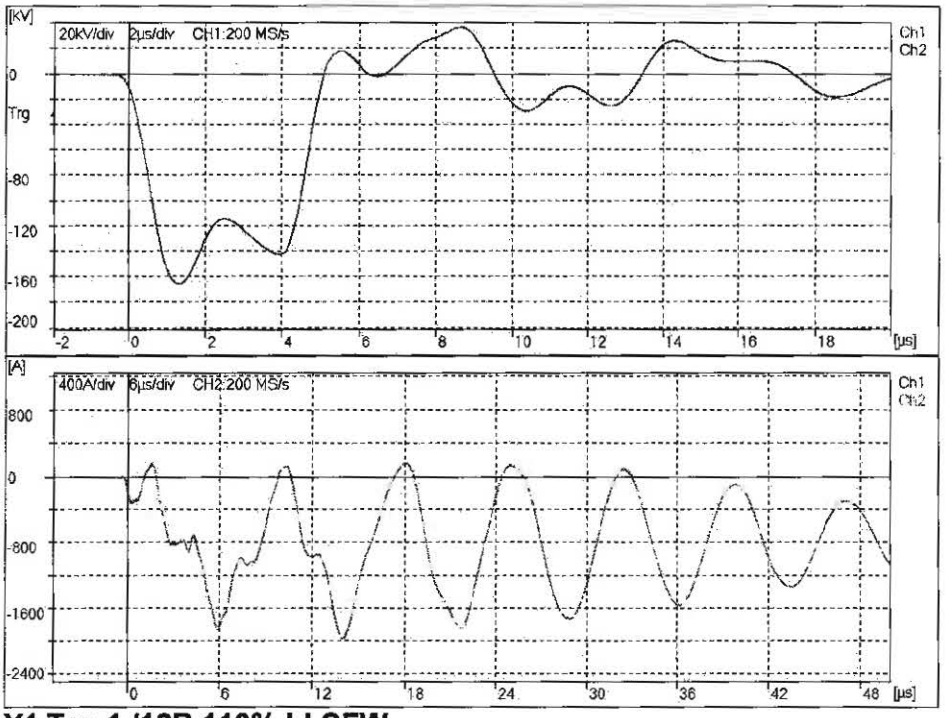
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: Y1
Up = -163.9 kV
T1 = 1.058 µs
Tc = 4.004 µs
Ch2: Y2+Y3
+Ip = 149.8 A
-Ip = -1970 A

Y1 Tap 1 /16R 110% LI CFW



No = 4
Ch1: Y1
Up = -165.3 kV
T1 = 1.059 µs
Tc = 4.045 µs
Ch2: Y2+Y3
+Ip = 169.6 A
-Ip = -1972 A

Y1 Tap 1 /16R 110% LI CFW

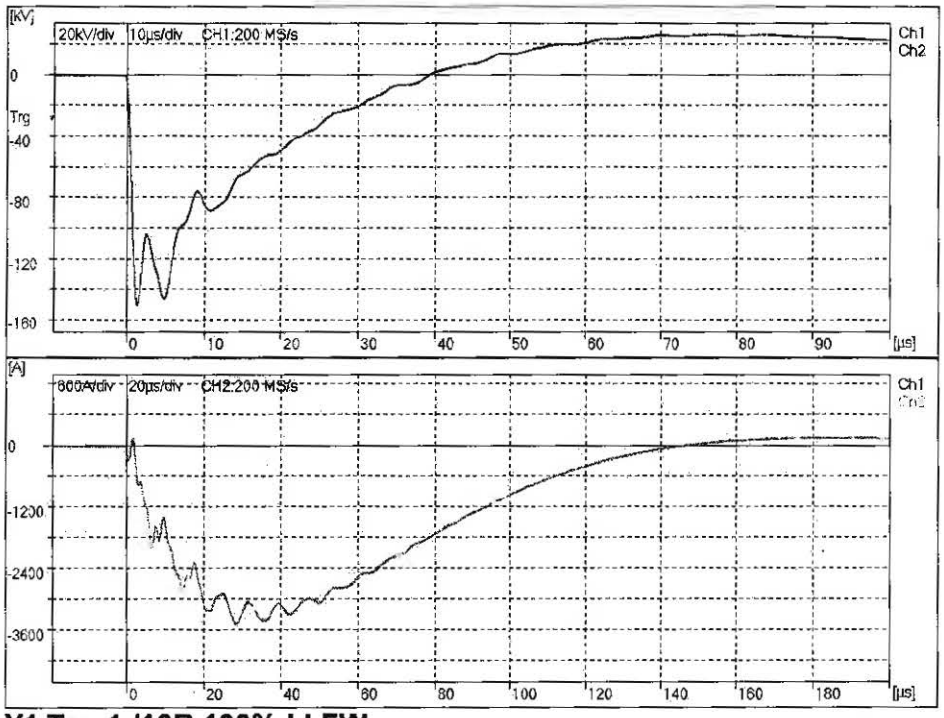
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

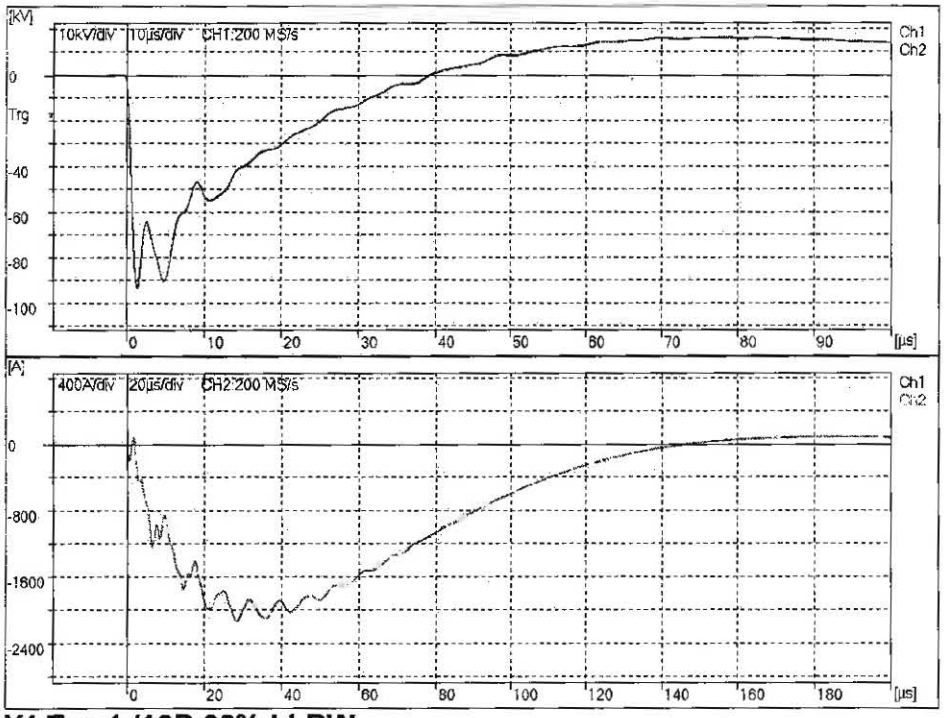
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: Y1
Up = -150.6 kV
T1 = 1.057 µs
T2 = 13.51 µs
Ch2: Y2+Y3
+Ip = 165.1 A
-Ip = -3480 A

Y1 Tap 1 /16R 100% LI FW

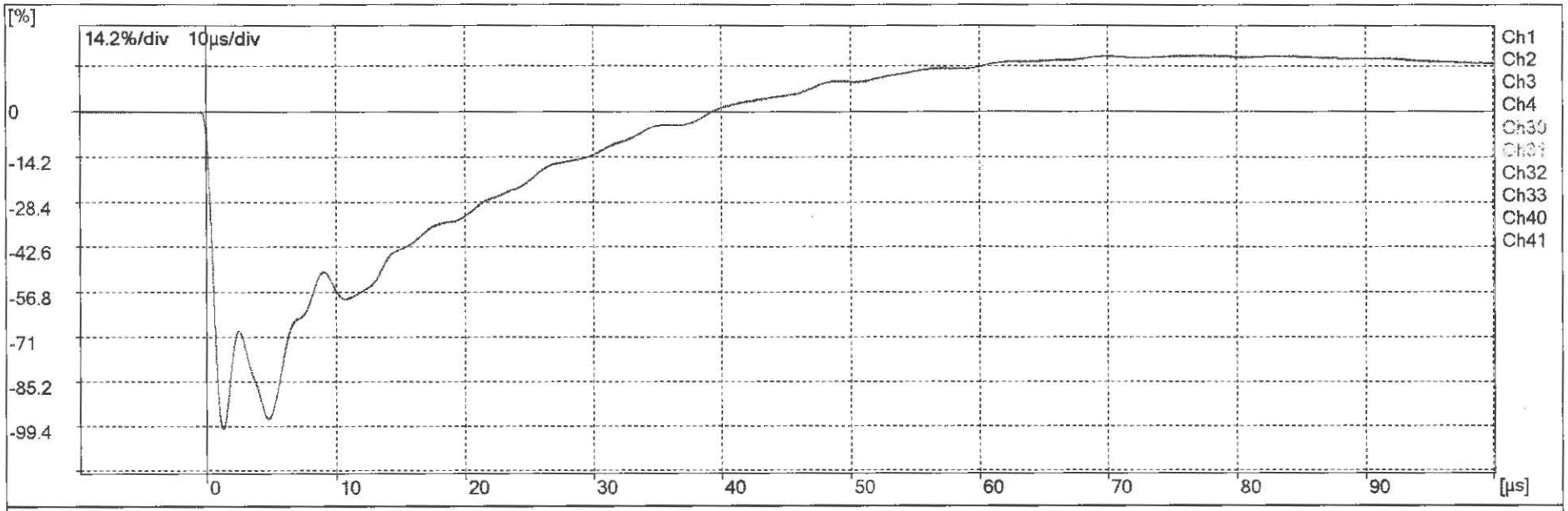


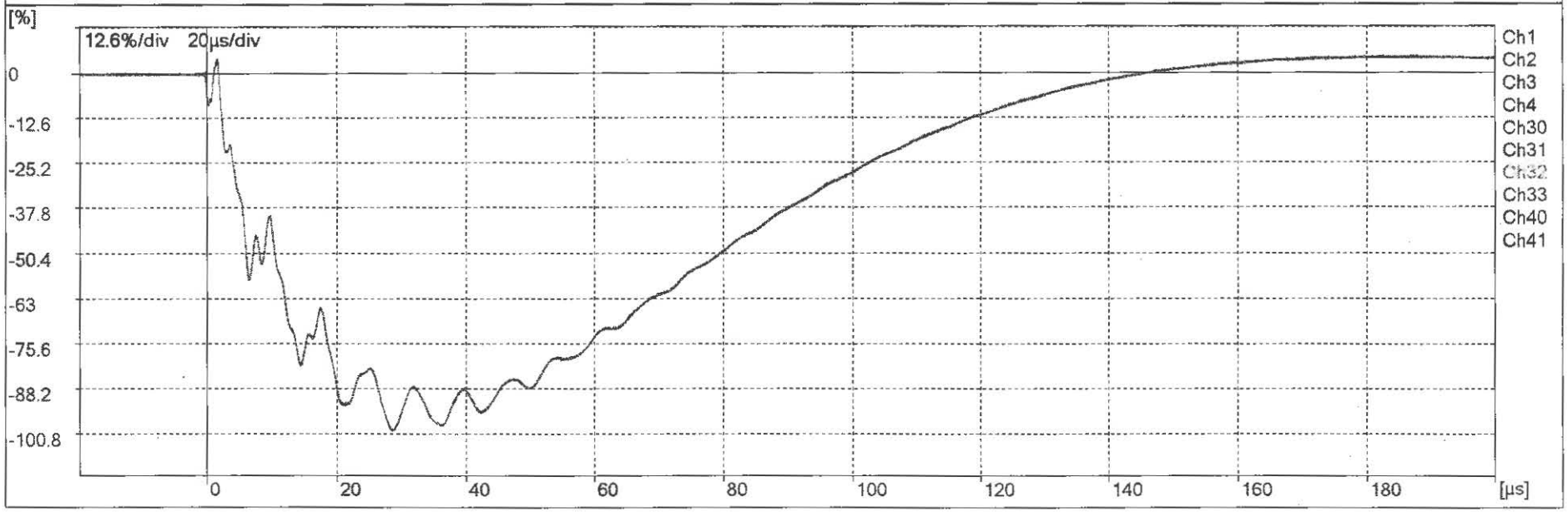
No = 6
Ch1: Y1
Up = -93.15 kV
T1 = 1.057 µs
T2 = 13.49 µs
Ch2: Y2+Y3
+Ip = 97.43 A
-Ip = -2130 A

Y1 Tap 1 /16R 62% LI RW

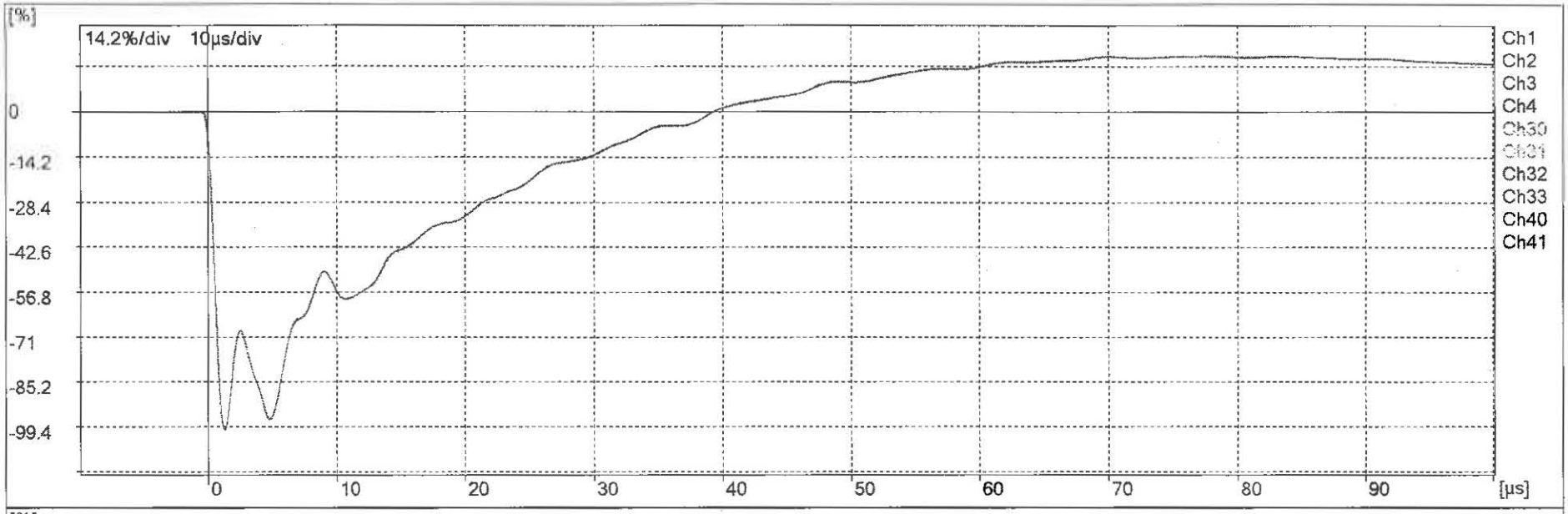
Date of test : 2/24/2013	Tested by : C. S. Ha

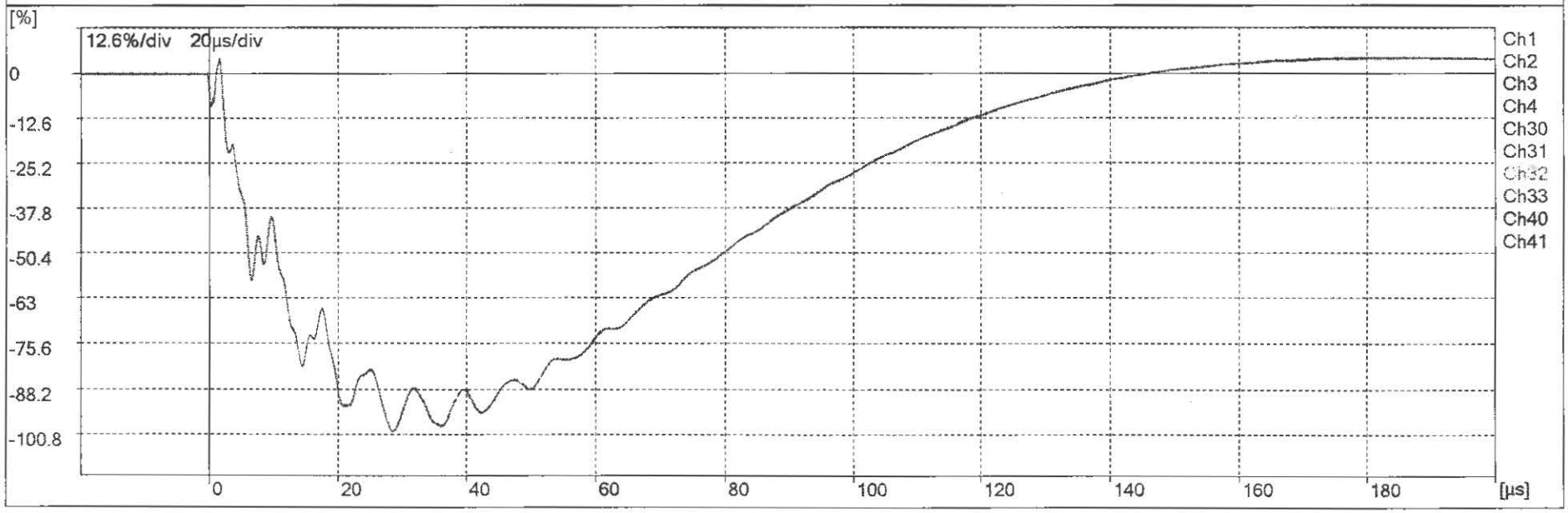
Y1 R-Fw - Fw


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

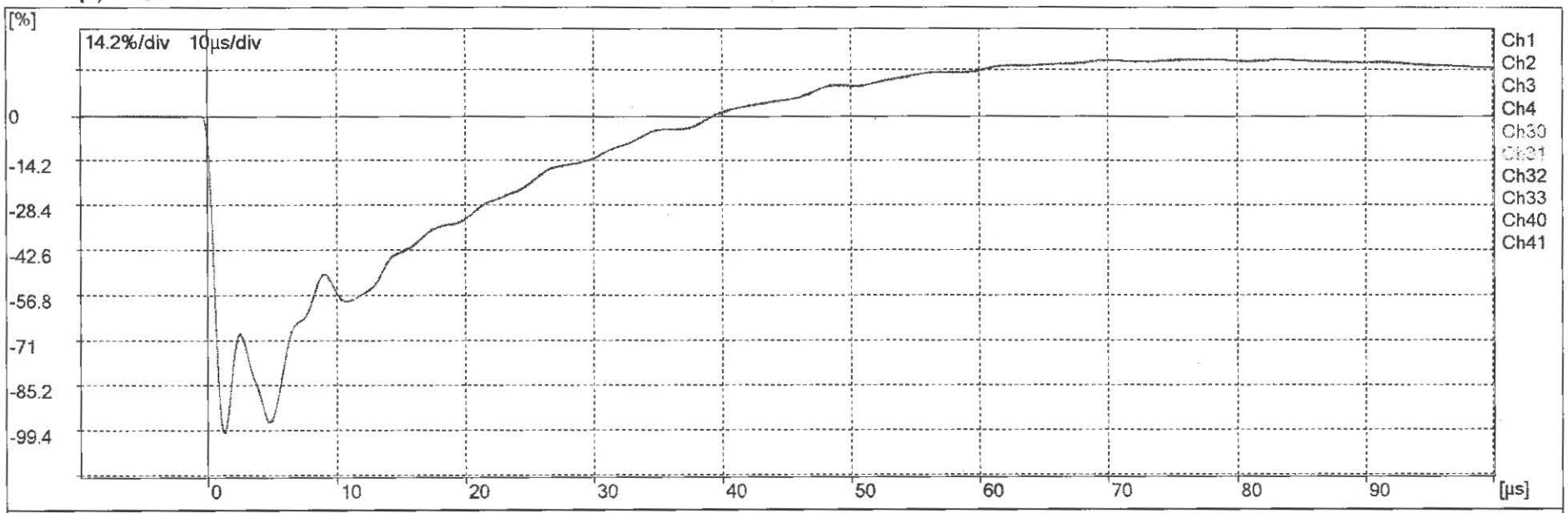

[%]
12.6%/div 20µs/div
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

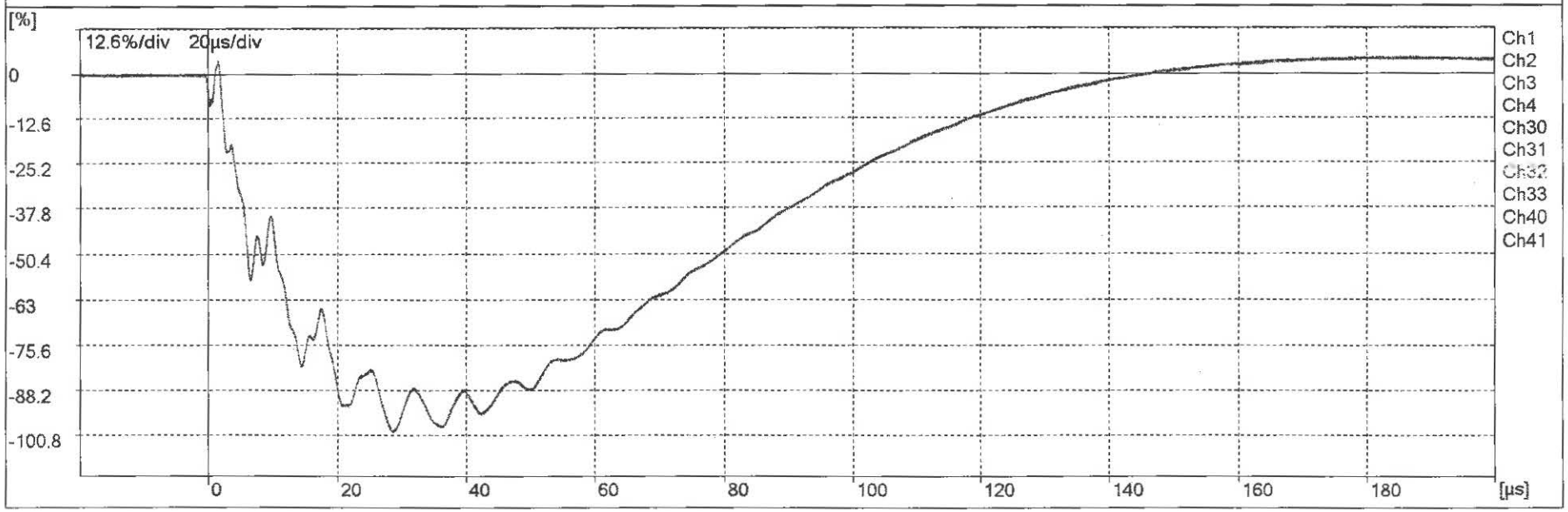
Y1 R.Fw - R.Fw


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12.6%/div 20µs/div
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

Y1 FW - FW


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

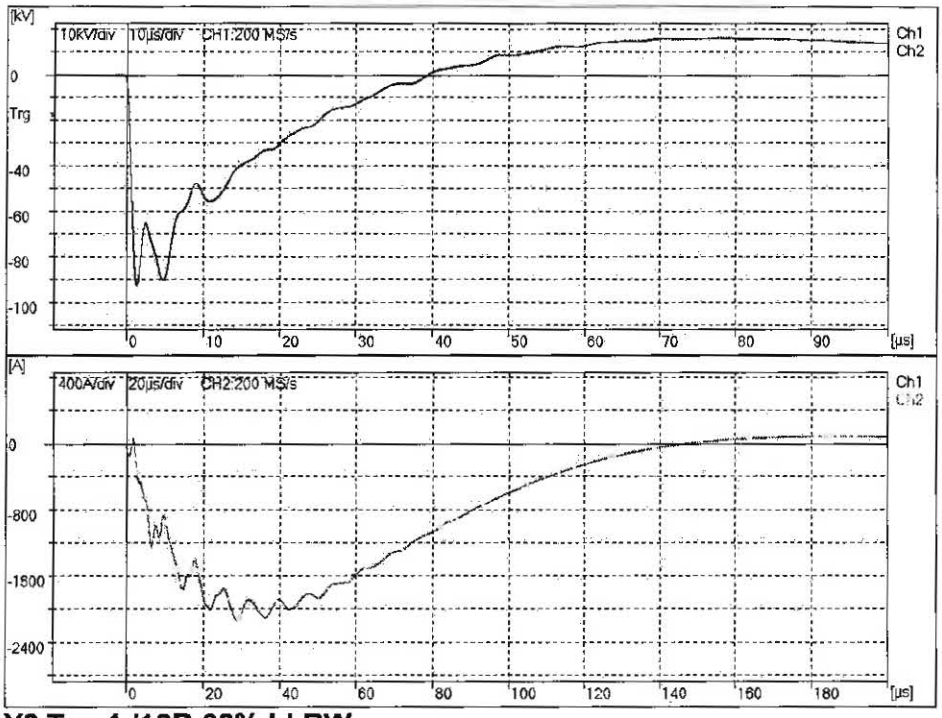

[%]
12.6%/div 20µs/div
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

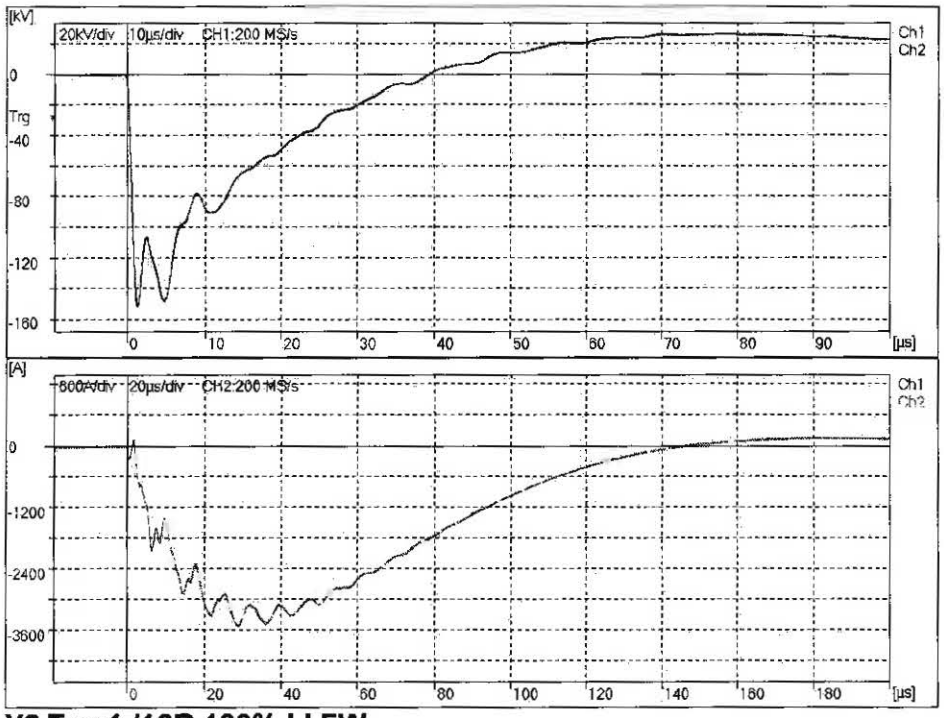
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: Y2
Up = -92.45 kV
T1 = 1.058 μs
T2 = 13.33 μs
Ch2: Y1+Y3
+Ip = 95.35 A
-Ip = -2133 A

Y2 Tap 1 /16R 62% LI RW



No = 2
Ch1: Y2
Up = -151.4 kV
T1 = 1.057 μs
T2 = 13.34 μs
Ch2: Y1+Y3
+Ip = 167.2 A
-Ip = -3518 A

Y2 Tap 1 /16R 100% LI FW

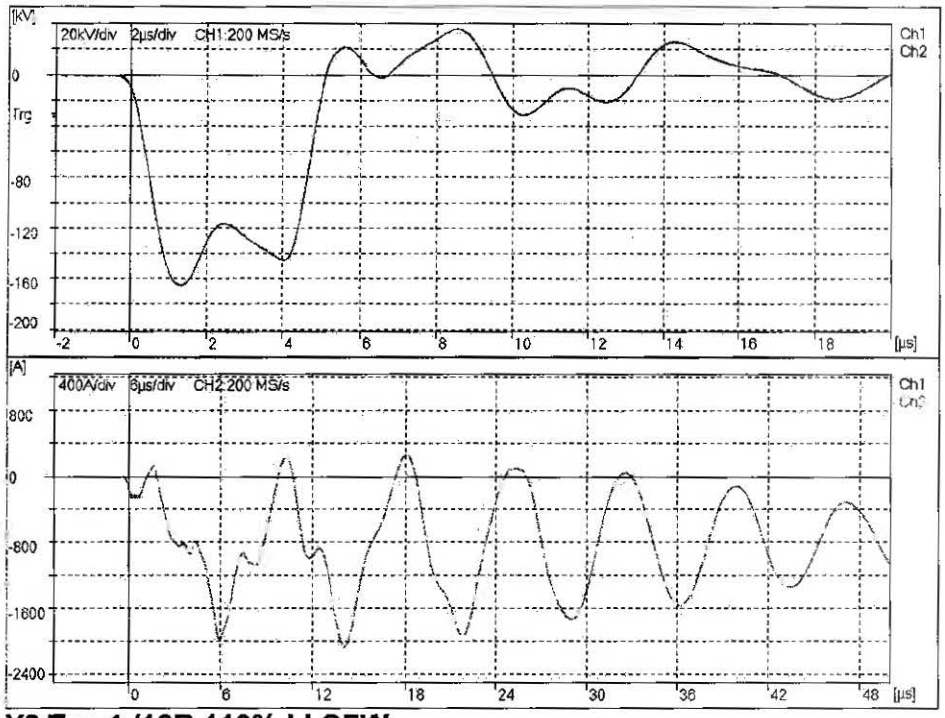
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO. LTD

Lightning Impulses Test Report

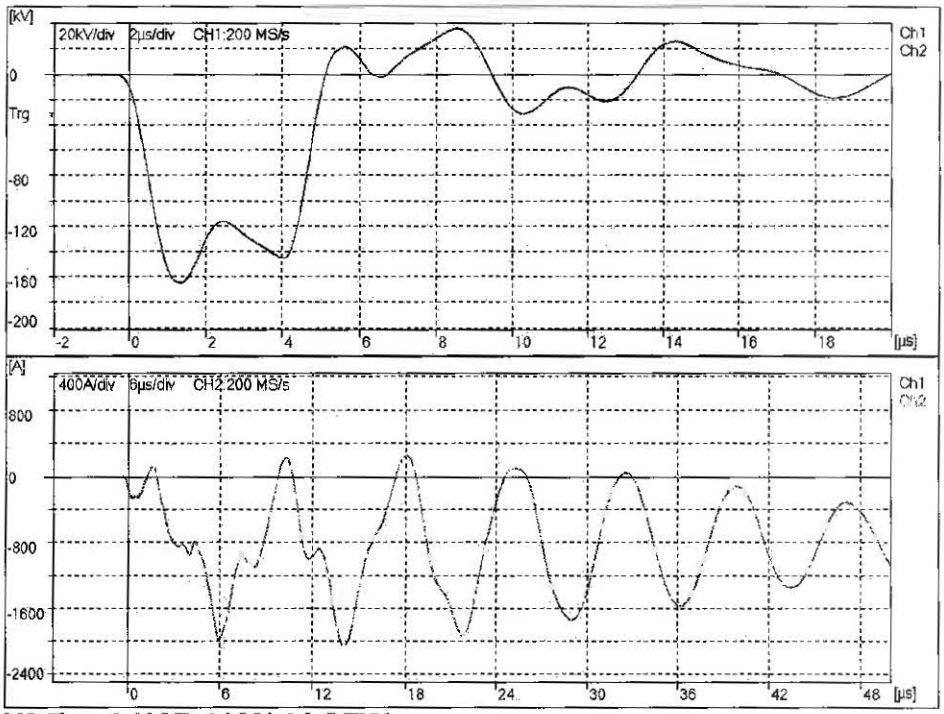
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: Y2
Up = -164.6 kV
T1 = 1.059 μs
Tc = 4.023 μs
Ch2: Y1+Y3
+Ip = 264.1 A
-Ip = -2059 A

Y2 Tap 1 /16R 110% LI CFW



No = 4
Ch1: Y2
Up = -164.3 kV
T1 = 1.060 μs
Tc = 4.131 μs
Ch2: Y1+Y3
+Ip = 261.0 A
-Ip = -2062 A

Y2 Tap 1 /16R 110% LI CFW

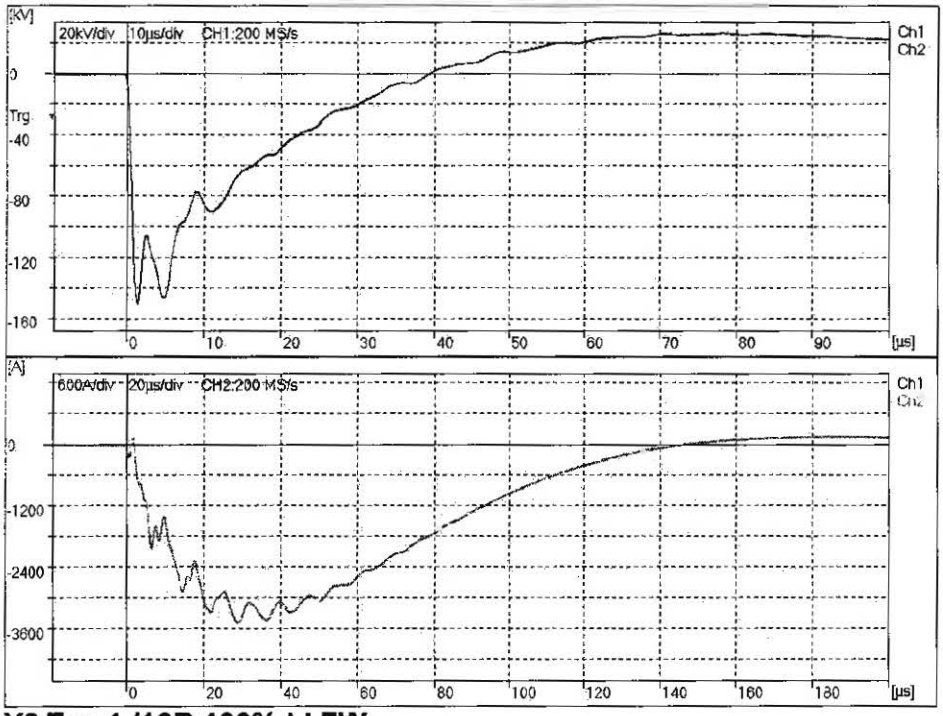
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

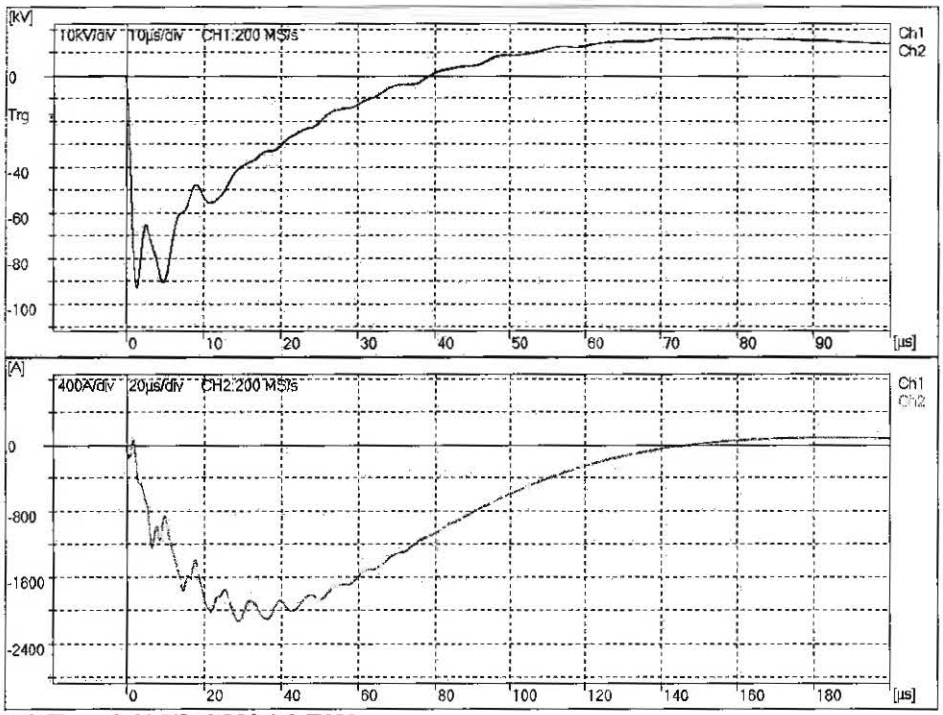
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: Y2
Up = -149.6 kV
T1 = 1.059 µs
T2 = 13.34 µs
Ch2: Y1+Y3
+Ip = 163.0 A
-Ip = -3488 A

Y2 Tap 1 /16R 100% LI FW

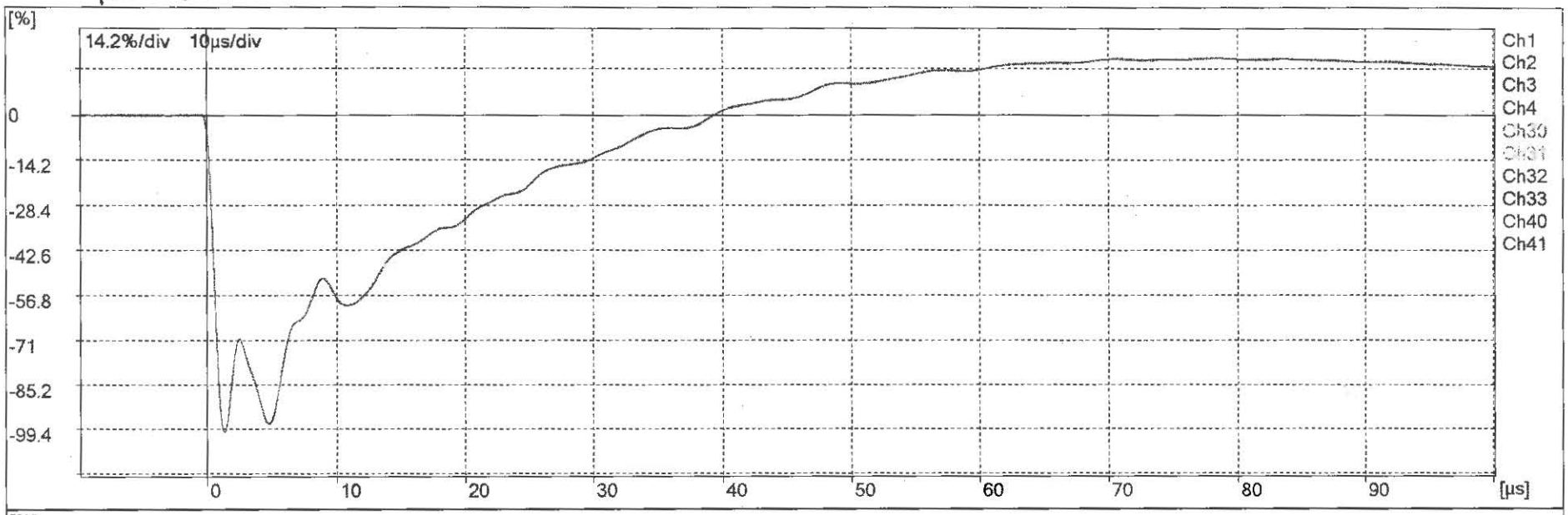


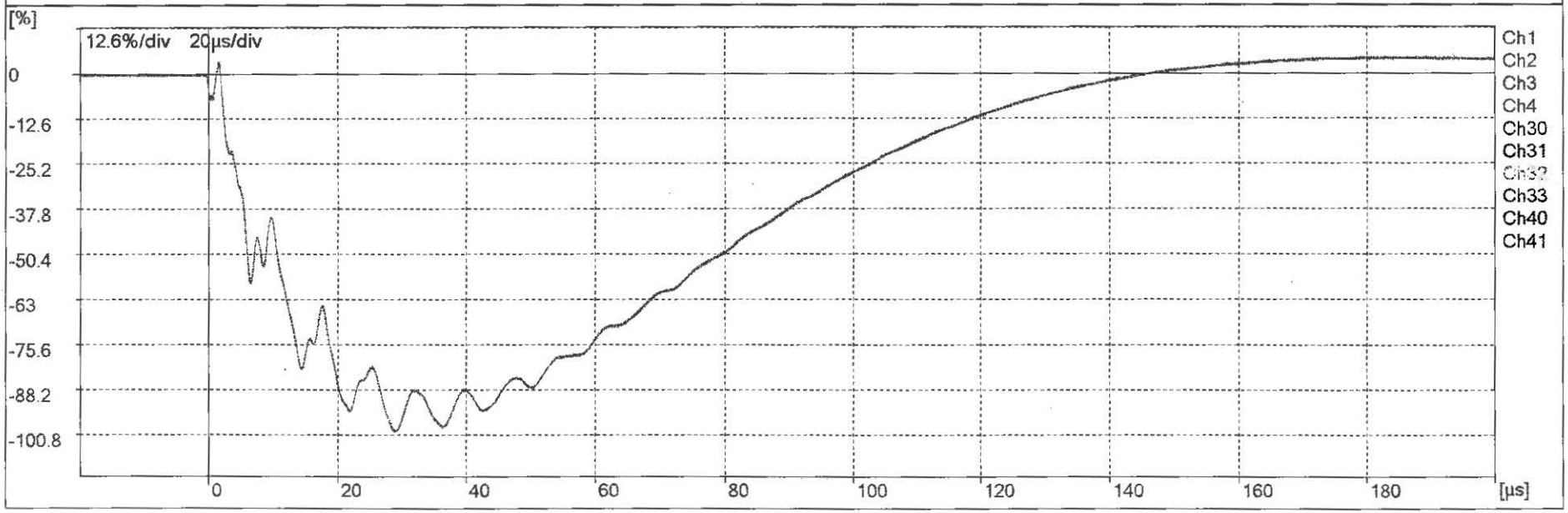
No = 6
Ch1: Y2
Up = -92.47 kV
T1 = 1.060 µs
T2 = 13.33 µs
Ch2: Y1+Y3
+Ip = 96.39 A
-Ip = -2133 A

Y2 Tap 1 /16R 62% LI RW

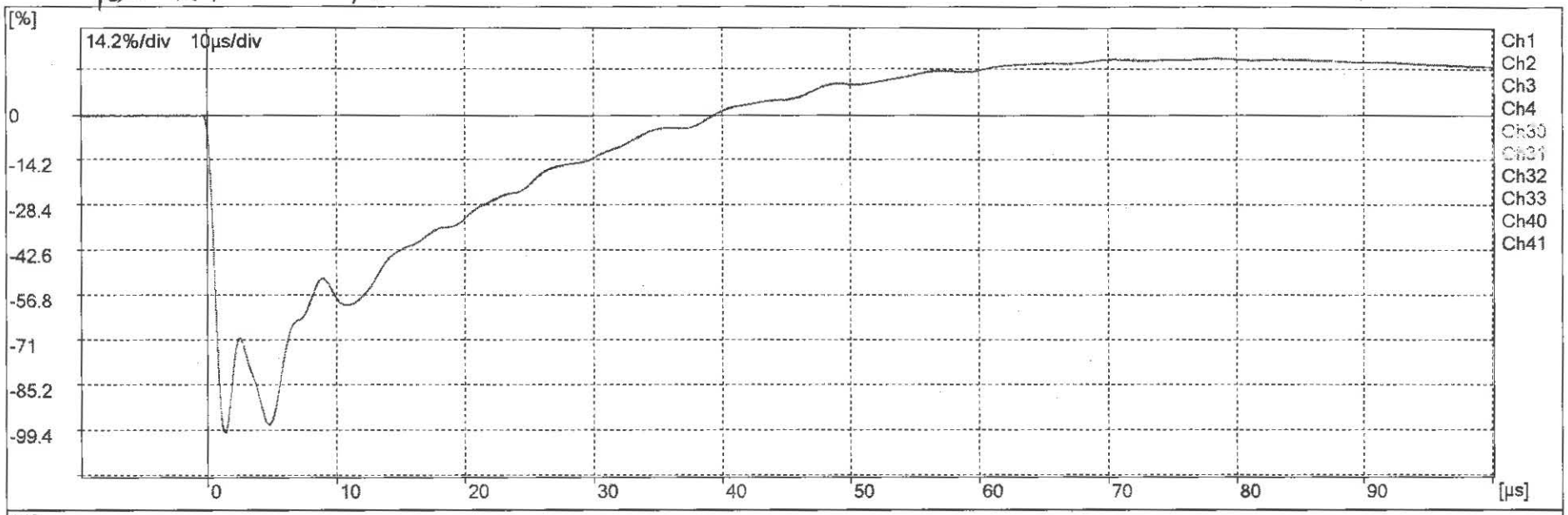
Date of test : 2/24/2013	Tested by : C. S. Ha

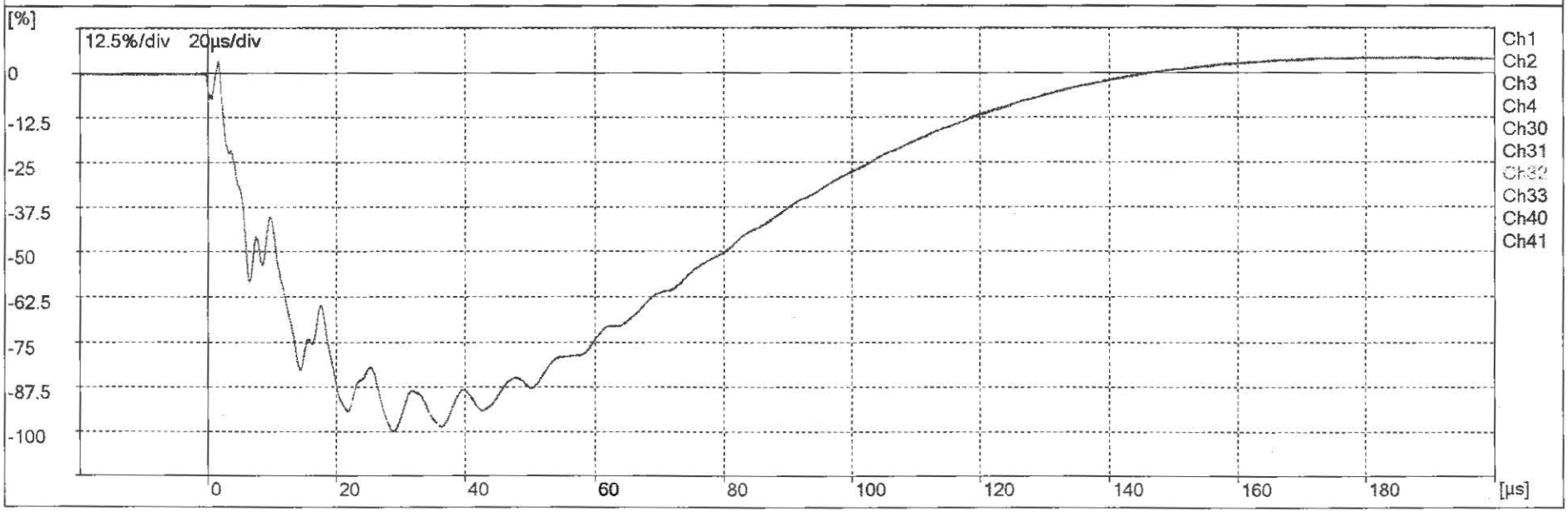
Y2 R.FW - FW


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

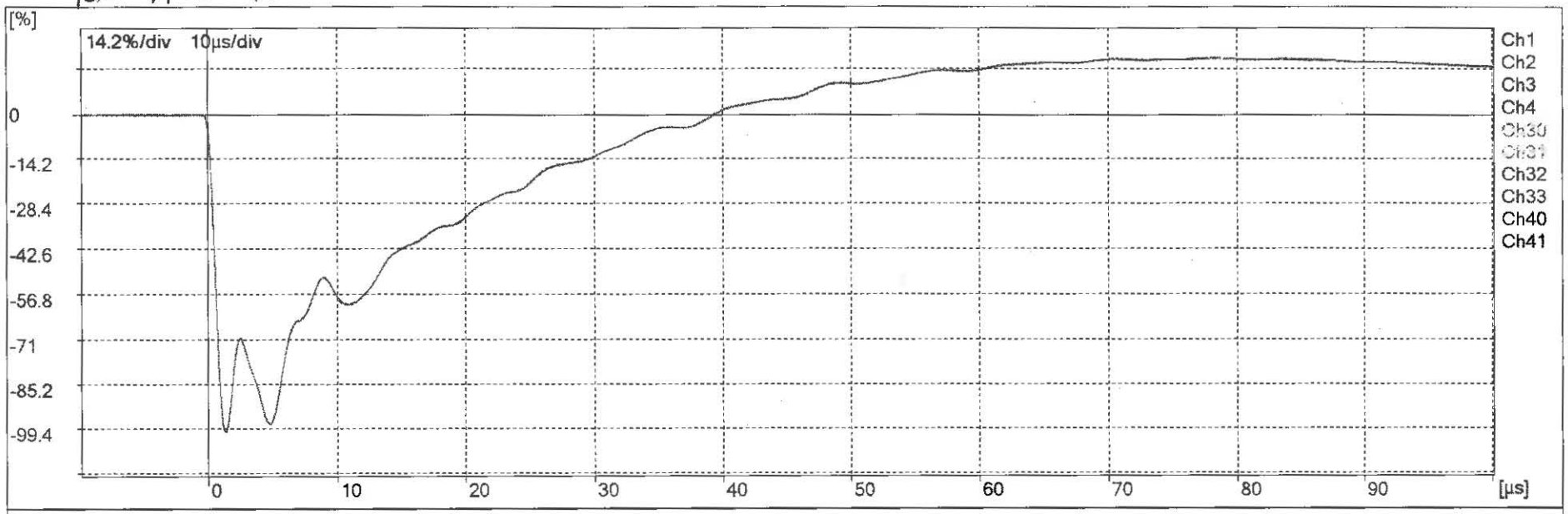

[%]
12.6%/div 20µs/div
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

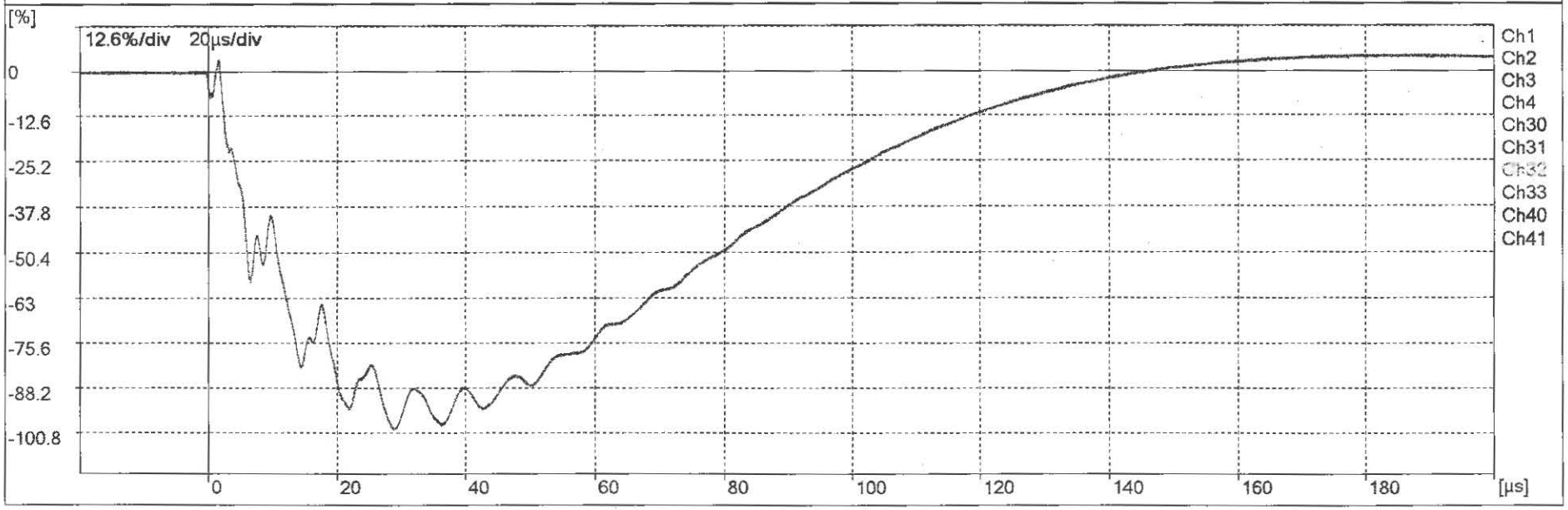
Y2 R.FW - R.FW


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12.5%/div 20µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

Y2 FW-FW


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41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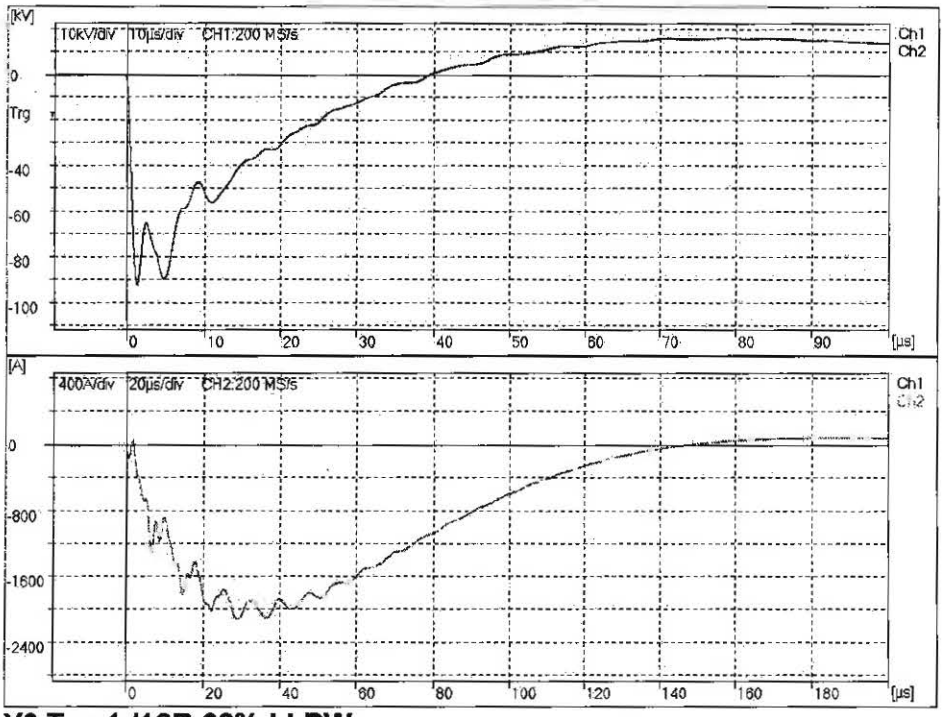
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO. LTD.

Lightning Impulses Test Report

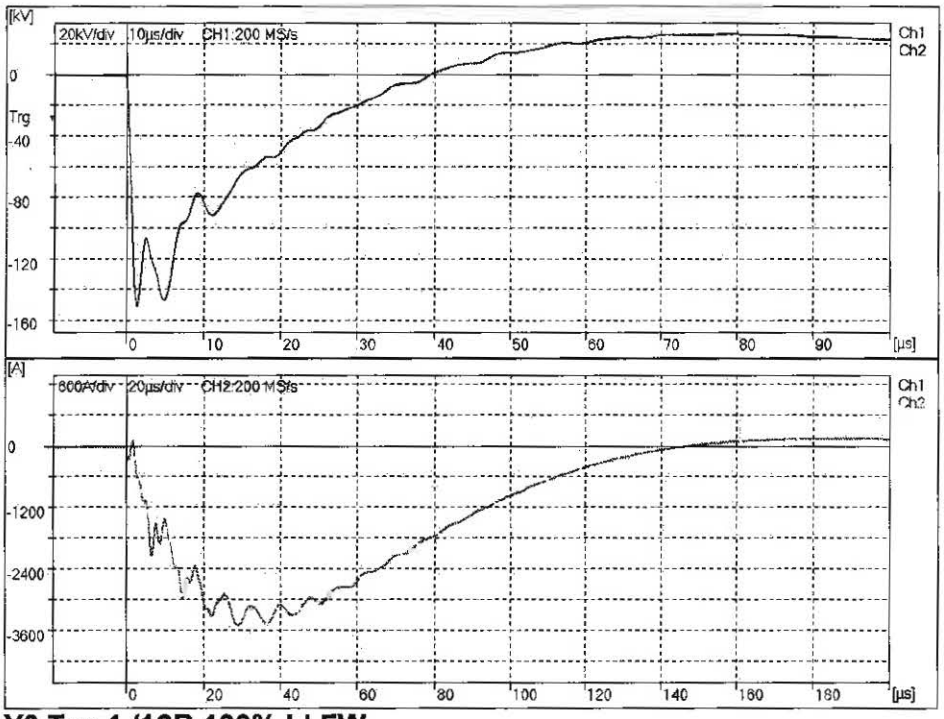
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 1
Ch1: Y3
Up = -91.95 kV
T1 = 1.057 μs
T2 = 13.54 μs
Ch2: Y1+Y2
+Ip = 96.39 A
-Ip = -2120 A

Y3 Tap 1 /16R 62% LI RW



No = 2
Ch1: Y3
Up = -150.4 kV
T1 = 1.057 μs
T2 = 13.56 μs
Ch2: Y1+Y2
+Ip = 165.1 A
-Ip = -3497 A

Y3 Tap 1 /16R 100% LI FW

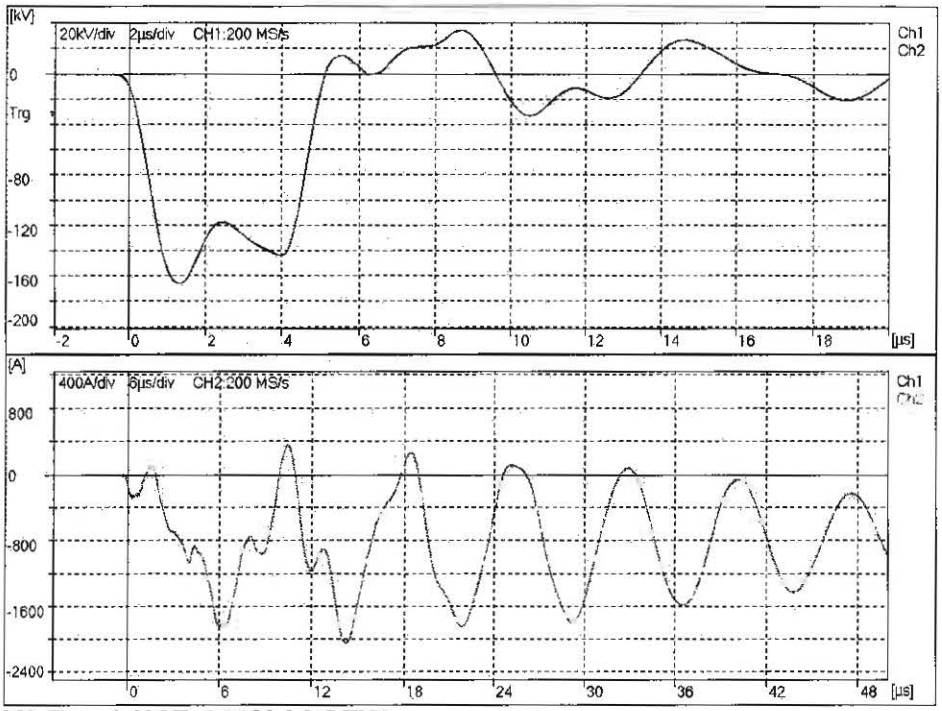
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

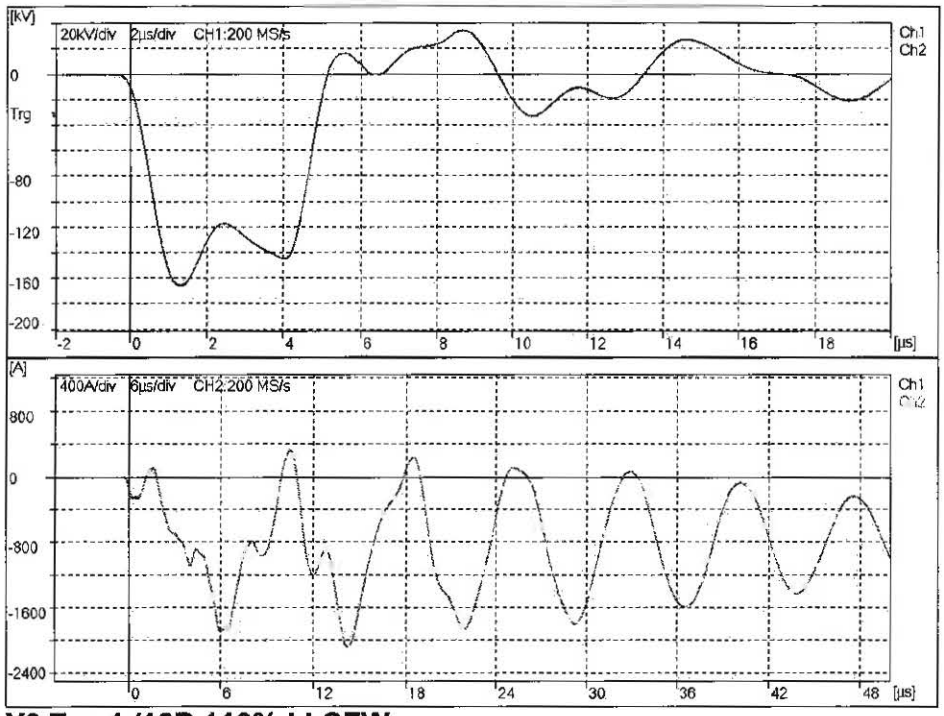
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 3
Ch1: Y3
Up = -165.3 kV
T1 = 1.059 µs
Tc = 4.069 µs
Ch2: Y1+Y2
+Ip = 365.9 A
-Ip = -2043 A

Y3 Tap 1 /16R 110% LI CFW



No = 4
Ch1: Y3
Up = -165.2 kV
T1 = 1.059 µs
Tc = 4.126 µs
Ch2: Y1+Y2
+Ip = 335.8 A
-Ip = -2076 A

Y3 Tap 1 /16R 110% LI CFW

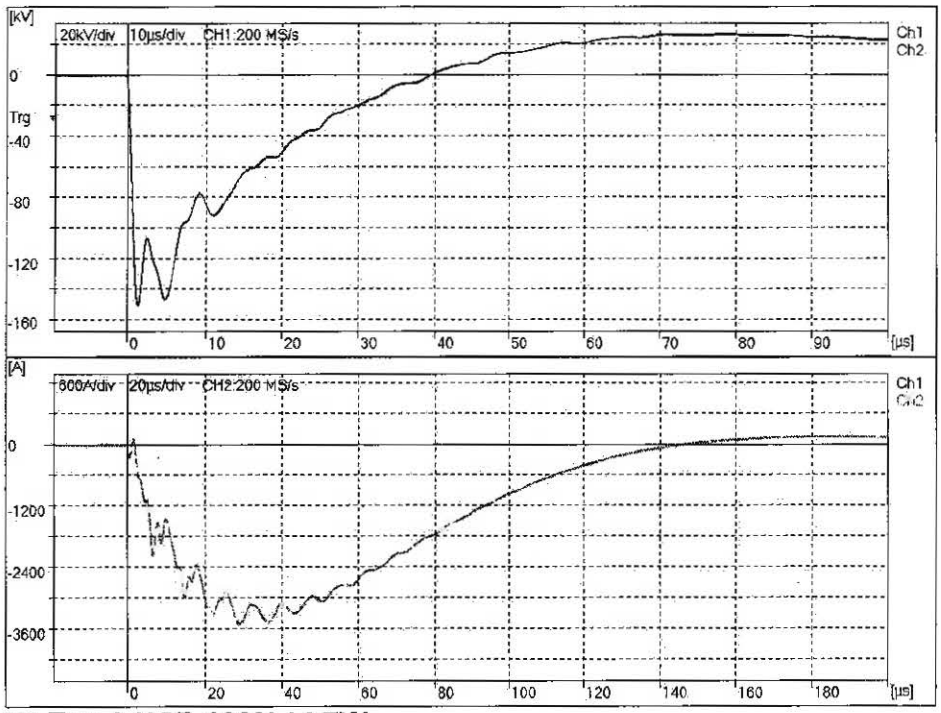
Date of test : 2/24/2013	Tested by : C. S. Ha

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Lightning Impulses Test Report

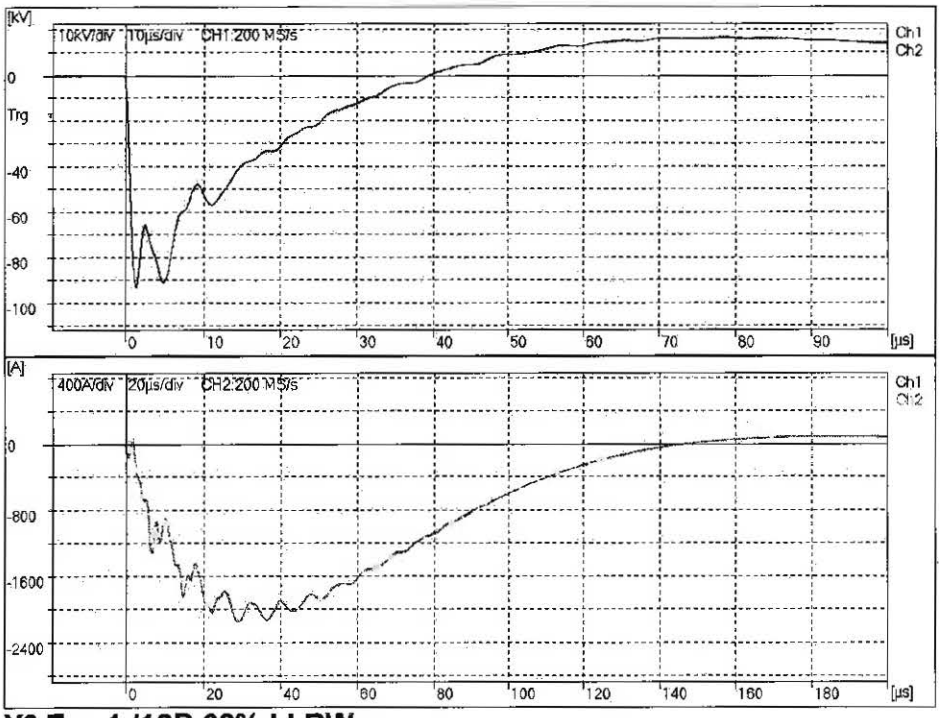
Serial No.
20120871TKE001

LI-Lightning Impulse Pictures



No = 5
Ch1: Y3
Up = -150.3 kV
T1 = 1.059 µs
T2 = 13.57 µs
Ch2: Y1+Y2
+Ip = 165.1 A
-Ip = -3501 A

Y3 Tap 1 /16R 100% LI FW

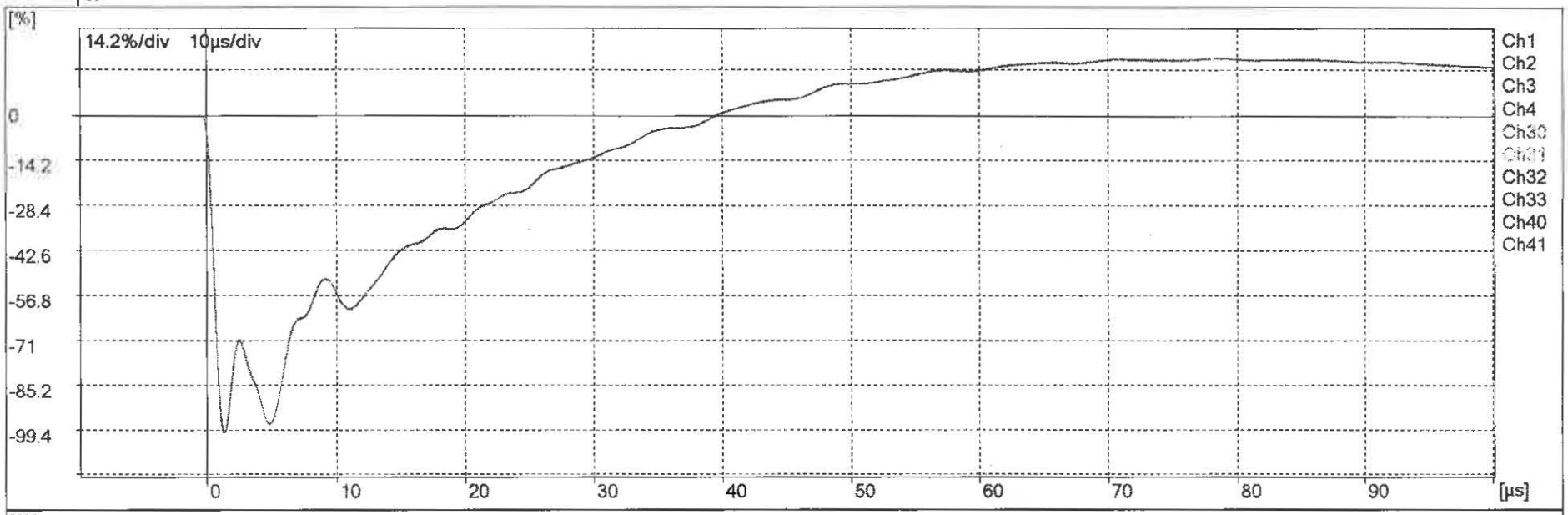


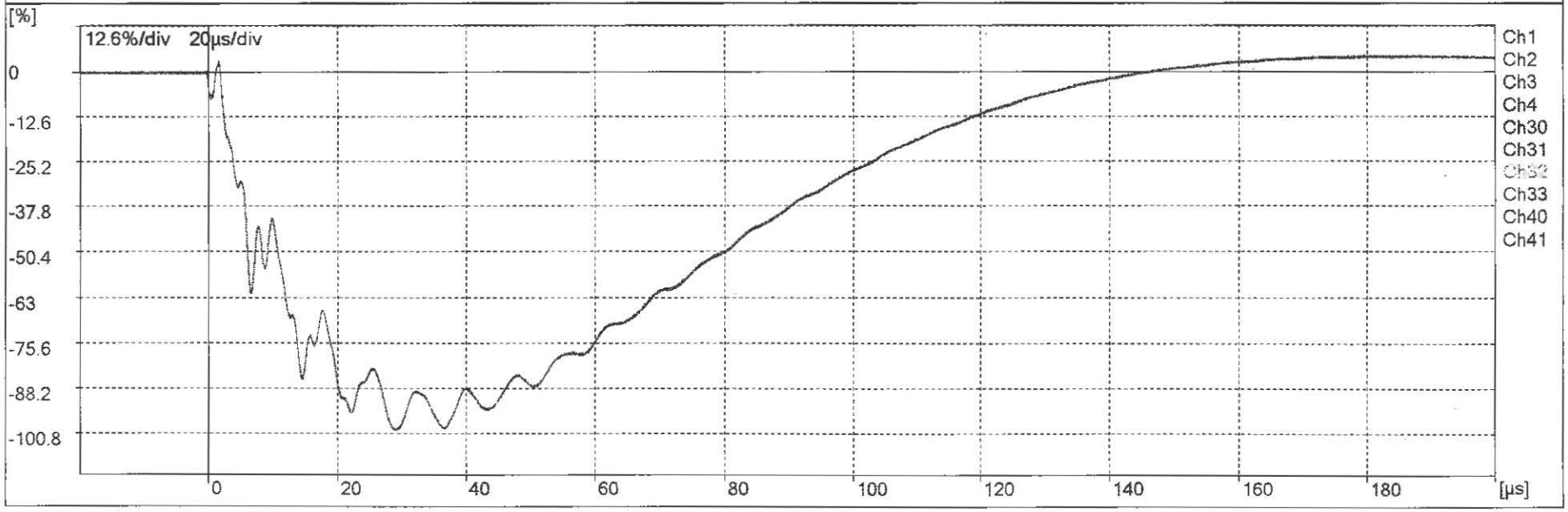
No = 6
Ch1: Y3
Up = -92.97 kV
T1 = 1.059 µs
T2 = 13.56 µs
Ch2: Y1+Y2
+Ip = 96.39 A
-Ip = -2147 A

Y3 Tap 1 /16R 62% LI RW

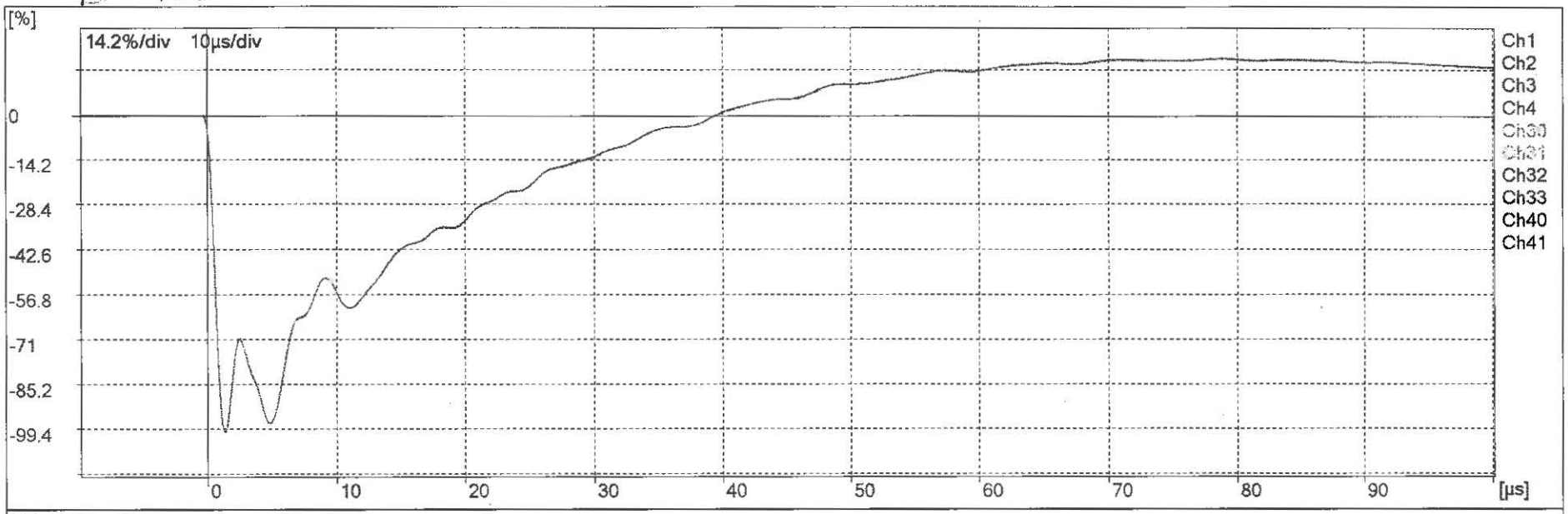
Date of test : 2/24/2013	Tested by : C. S. Ha

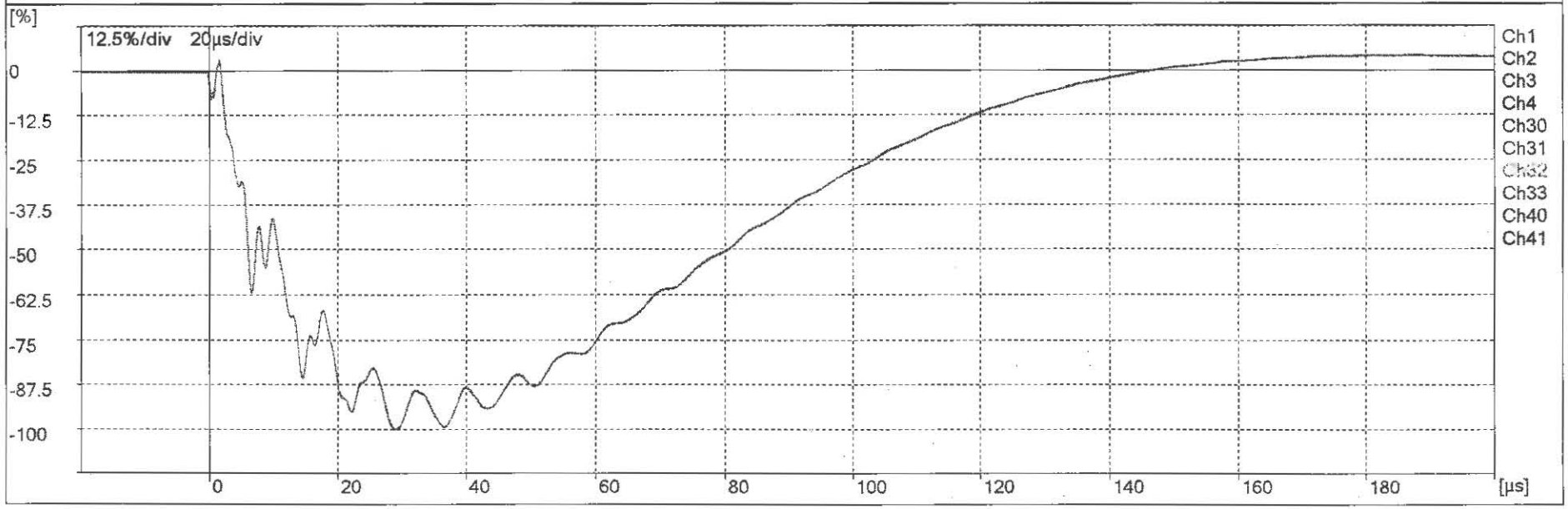
Y3 R.FW −FW'


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

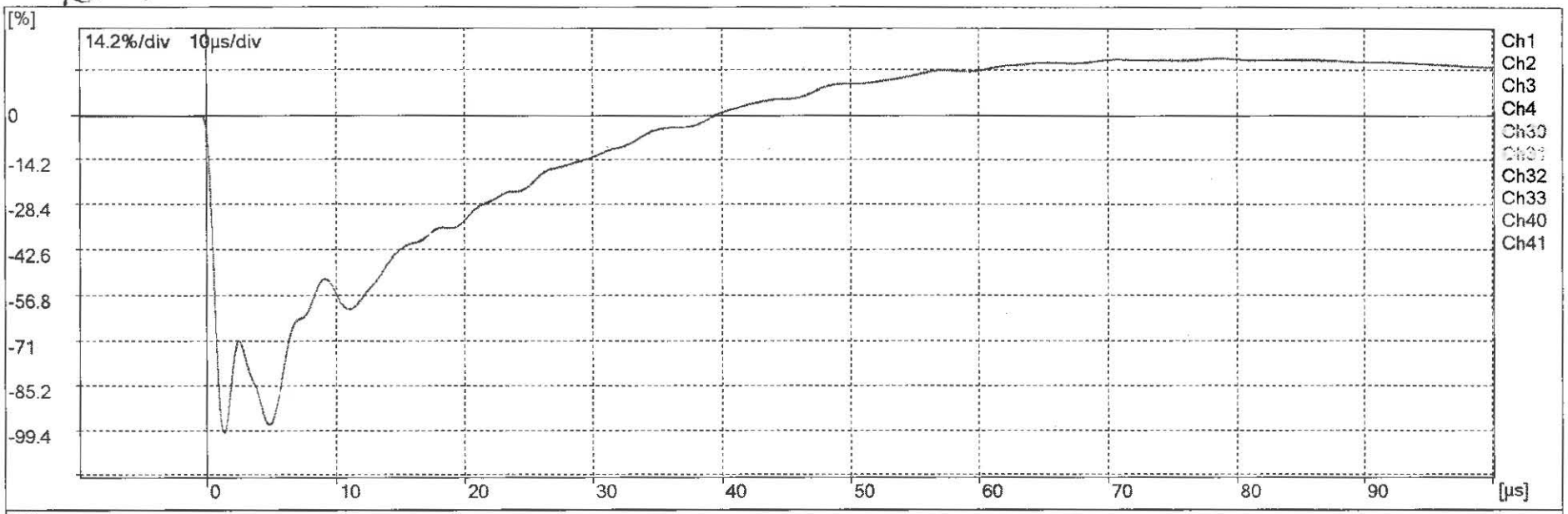

[%]
12.6%/div 20µs/div
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

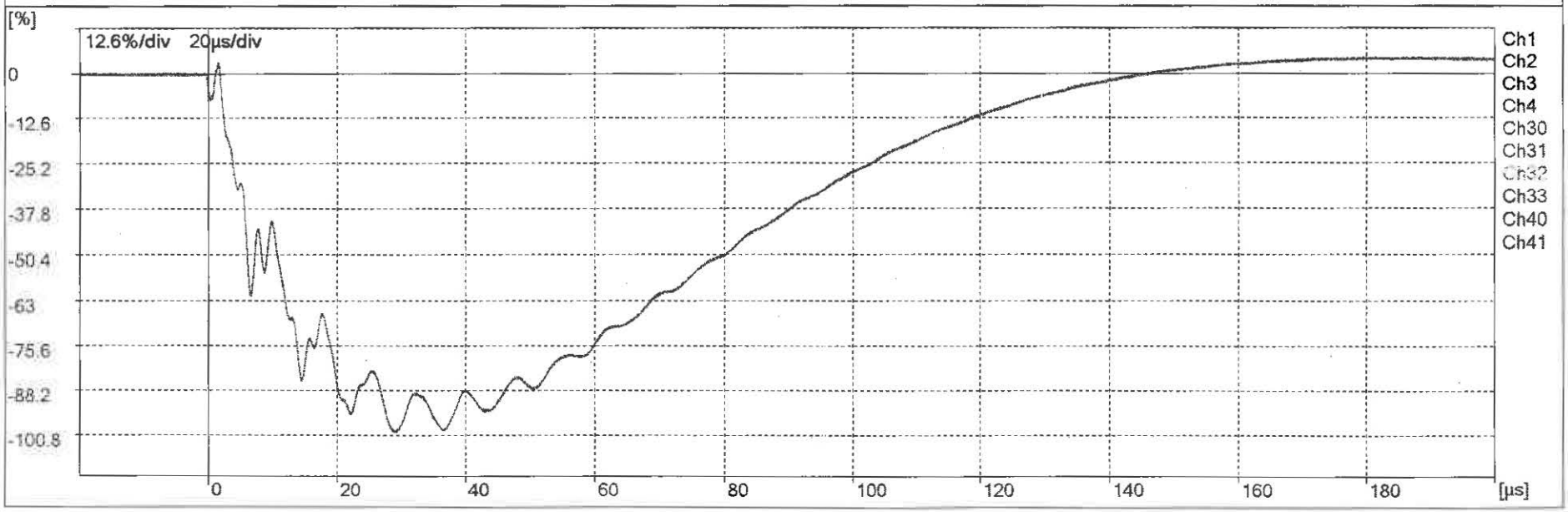
Y3 R.Fw - R.Fw


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12.5%/div 20µs/div
0
-12.5
-25
-37.5
-50
-62.5
-75
-87.5
-100
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

Y3 FW – FW


[%]
14.2%/div 10µs/div
0
-14.2
-28.4
-42.6
-56.8
-71
-85.2
-99.4
0
10
20
30
40
50
60
70
80
90
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41


[%]
12.6%/div 20µs/div
0
-12.6
-25.2
-37.8
-50.4
-63
-75.6
-88.2
-100.8
0
20
40
60
80
100
120
140
160
180
[µs]
Ch1
Ch2
Ch3
Ch4
Ch30
Ch31
Ch32
Ch33
Ch40
Ch41

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Applied voltage withstand test

Serial No.
20120871TKE001

Item	Test Voltage		Test frequency		Test time	Test result
HV/LV winding & neutral to earth	50.0	kV	60	Hz	60 sec.	Withstood
TV winding to earth	50.0	kV	60	Hz	60 sec.	Withstood

Date of Test : 2013. 02. 25

Tested by : S. W. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Induced Overvoltage Withstand test with P.D measurement

Serial No. 20120871TKE001

1. Test condition : a) TV Supply, HV Measured.
   b) Tap position. : DETC-1/LTC-16R
   c) Test frequency : 180 Hz.

2. Test voltage & Time
   a) U1 HV/LV Phase to ground voltage : 360.0 / 150.0 kV 40 sec.
   b) U2 HV/LV Phase to ground voltage : 315.0 / 132.0 kV 60 min.

3. Test results (HV)

HV voltage (kV) (Phase to ground)			H1 terminal	H2 terminal	H3 terminal
			Actual P.D level (pC)	Actual P.D level (pC)	Actual P.D level (pC)
315.0	U2	-	40.0	45.0	40.0
315.0	U2	5min.	41.0	45.0	47.0
360.0	U1	40sec	-	-	-
315.0	U2	-	40.0	62.0	46.0
315.0	U2	5min.	40.0	65.0	45.0
315.0	U2	10min.	40.0	60.0	40.0
315.0	U2	15min.	40.0	60.0	40.0
315.0	U2	20min.	40.0	60.0	45.0
315.0	U2	25min.	40.0	60.0	45.0
315.0	U2	30min.	40.0	65.0	45.0
315.0	U2	35min.	40.0	65.0	45.0
315.0	U2	40min.	40.0	70.0	40.0
315.0	U2	45min.	41.0	75.0	40.0
315.0	U2	50min.	40.0	75.0	40.0
315.0	U2	55min.	40.0	75.0	40.0
315.0	U2	60min.	40.0	65.0	40.0

Date of Test : 2013. 02. 25 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Induced Overvoltage Withstand test with P.D measurement

Serial No. 20120871TKE001

1. Test condition : a) TV Supply, LV Measured.
   b) Tap position. : DETC-1/LTC-16R
   c) Test frequency : 180 Hz.

2. Test voltage & Time
   a) U1 HV/LV Phase to ground voltage : 360.0 / 150.0 kV 40 sec.
   b) U2 HV/LV Phase to ground voltage : 315.0 / 132.0 kV 60 min.

3. Test results (LV)

LV voltage (kV) (Phase to ground)			X1 terminal	X2 terminal	X3 terminal
			Actual P.D level (pC)	Actual P.D level (pC)	Actual P.D level (pC)
132.0	U2	-	70.0	70.0	83.0
132.0	U2	5min.	70.0	70.0	81.0
150.0	U1	40sec	-	-	-
132.0	U2	-	70.0	68.0	82.0
132.0	U2	5min.	70.0	68.0	80.0
132.0	U2	10min.	70.0	68.0	80.0
132.0	U2	15min.	71.0	69.0	80.0
132.0	U2	20min.	70.0	68.0	80.0
132.0	U2	25min.	70.0	68.0	80.0
132.0	U2	30min.	71.0	67.0	81.0
132.0	U2	35min.	70.0	67.0	81.0
132.0	U2	40min.	70.0	68.0	80.0
132.0	U2	45min.	70.0	68.0	80.0
132.0	U2	50min.	71.0	69.0	81.0
132.0	U2	55min.	70.0	68.0	80.0
132.0	U2	60min.	70.0	68.0	80.0

Date of Test : 2013. 02. 25 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Radio-influence voltage (R.I.V) measurement

Serial No. 20120871TKE001

1. Test condition : a) TV Supply, HV Measured.
   b) Tap position. : DETC-1/LTC-16R
   c) Test frequency : 180 Hz.

2. Test voltage & Time
   a) U1 HV/LV Phase to ground voltage : 360.0 / 150.0 kV 40 sec.
   b) U2 HV/LV Phase to ground voltage : 315.0 / 132.0 kV 60 min.

3. Test results (HV)

HV voltage (kV) (Phase to ground)			H1 terminal	H2 terminal	H3 terminal
			Actual R.I.V level (μV)	Actual R.I.V level (μV)	Actual R.I.V level (μV)
315.0	U2	-	23.0	21.0	38.0
315.0	U2	5min.	23.0	21.0	38.0
360.0	U1	40sec		-	-
315.0	U2	-	23.0	21.0	38.0
315.0	U2	5min.	23.0	21.0	38.0
315.0	U2	10min.	23.0	21.0	38.0
315.0	U2	15min.	23.0	21.0	39.0
315.0	U2	20min.	23.0	22.0	38.0
315.0	U2	25min.	23.0	21.0	38.0
315.0	U2	30min.	23.0	21.0	37.0
315.0	U2	35min.	24.0	22.0	38.0
315.0	U2	40min.	24.0	21.0	38.0
315.0	U2	45min.	24.0	21.0	37.0
315.0	U2	50min.	24.0	21.0	38.0
315.0	U2	55min.	24.0	22.0	38.0
315.0	U2	60min.	24.0	21.0	38.0

Date of Test : 2013. 02. 25	Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Radio-influence voltage (R.I.V) measurement

Serial No. 20120871TKE001

1. Test condition : a) TV Supply, LV Measured.
   b) Tap position. : DETC-1/LTC-16R
   c) Test frequency : 180 Hz.

2. Test voltage & Time
   a) U1 HV/LV Phase to ground voltage : 360.0 / 150.0 kV 40 sec.
   b) U2 HV/LV Phase to ground voltage : 315.0 / 132.0 kV 60 min.

3. Test results (LV)

LV voltage (kV) (Phase to ground)			X1 terminal	X2 terminal	X3 terminal
			Actual R.I.V level (μV)	Actual R.I.V level (μV)	Actual R.I.V level (μV)
132.0	U2	-	27.0	25.0	28.0
132.0	U2	5min.	27.0	25.0	28.0
150.0	U1	40sec	-	-	-
132.0	U2	-	27.0	25.0	28.0
132.0	U2	5min.	27.0	25.0	28.0
132.0	U2	10min.	27.0	25.0	28.0
132.0	U2	15min.	27.0	26.0	28.0
132.0	U2	20min.	26.0	26.0	27.0
132.0	U2	25min.	27.0	25.0	27.0
132.0	U2	30min.	26.0	25.0	28.0
132.0	U2	35min.	27.0	25.0	29.0
132.0	U2	40min.	27.0	26.0	28.0
132.0	U2	45min.	26.0	25.0	28.0
132.0	U2	50min.	27.0	25.0	28.0
132.0	U2	55min.	27.0	25.0	29.0
132.0	U2	60min.	26.0	25.0	28.0

Date of Test : 2013. 02. 25 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

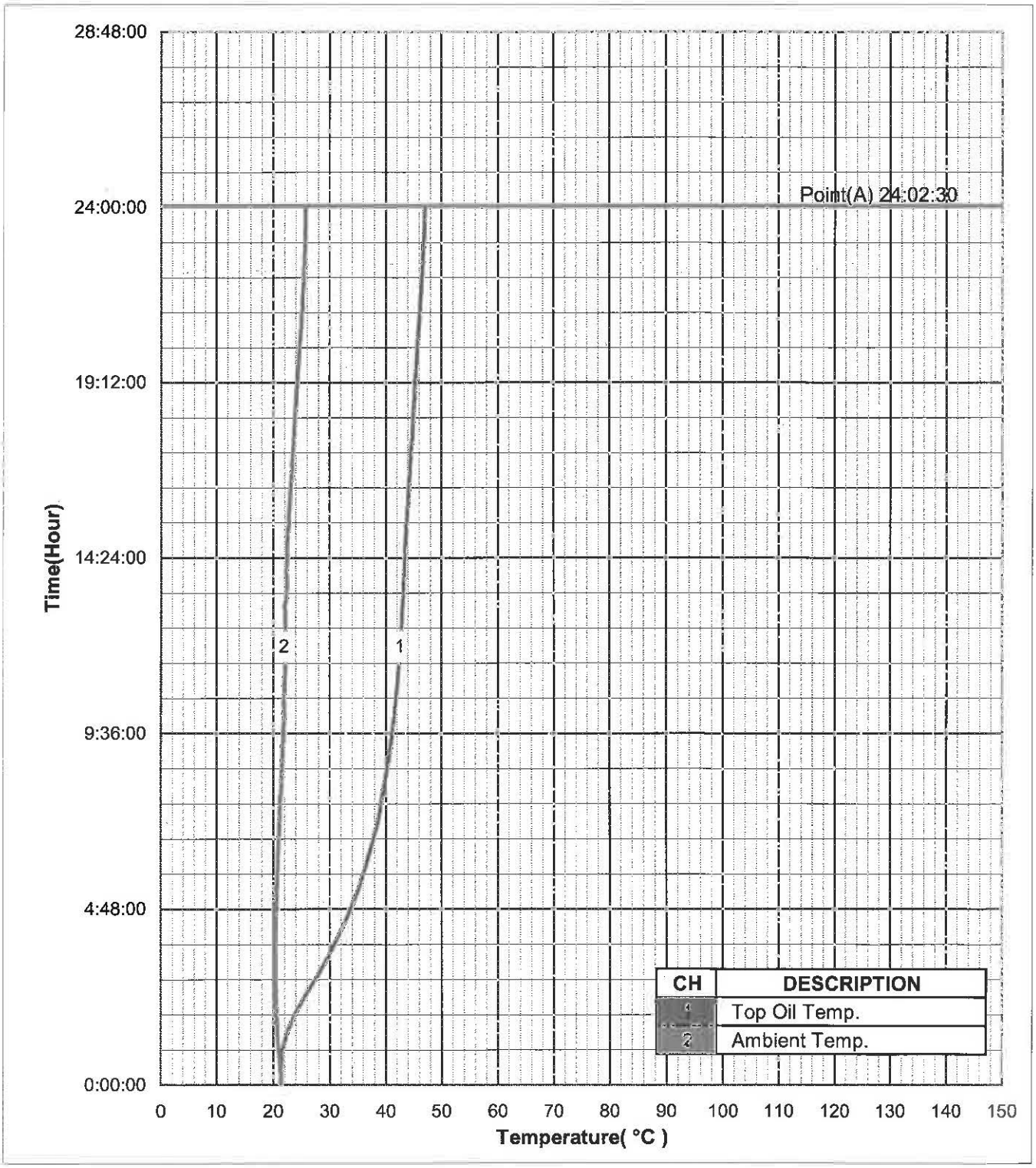
Temperature Recorder Chart

Serial No
20120871TKE001

Test Object : 24hours Overexciting test.

Test of Date : Feb-26-2013

Channel	*CH1*	*CH2*
Point(A)	47.1	25.7



Date of Test : 2013.02.26	Tested by : S. W. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Test of control cubicle
(Local control panel)

Serial No.
20120871TKE001

				Results
1. Visual dimension and component check				
in accordance with the approved drawings				
drawing No. :	TL2363-L01	~	TL2363-L02	Satisfactory
2. Wiring continuity and functional test				
in accordance with the approved drawings				
drawing No. :	TL2363-L03	~	TL2363-L08	Satisfactory

3. Insulation test

1) Conditions : Temp. 19 ℃ Hum. 39 %

2) Insulation resistance test with 1000 V Megger : 450 MΩ

3) Dielectric test 2000 V 60 Hz for 1min. — Withstood

4) B.C.T dielectric test 2500 V 60 Hz for 1min. — Withstood

Date of Test : 2013. 02. 25	Tested by : S. W. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Check List
(Protection device)

Serial No.
20120871TKE001

No.	Description		Function test		Remark
			Alarm	Trip	
1	Loss of main AC power		Good	-	27
2	Loss of DC power		Good	-	27D
3	Loss of AC Aux power		Good	-	52A-1, 52A-2
4	Cooling fan group1, 2 start		Good	-	4-F1, 4-F2
5	Fan control fault group1, 2		Good	-	62-1, 62-2
6	Loss of OLTC AC power		Good	-	27L
7	90 Relay failure		Good	-	90
8	Shutter valve		Good	-	80Q
9	Main Tank Oil level Indicator		Good	Good	71Q1 (High,Low)
10	Main Conservator Oil level Indicator		Good	Good	71Q2 (High,Low)
11	OLTC Oil level Indicator		Good	Good	71Q3 (High,Low)
12	Main Pressure relief device		Good	-	63P1, 63P2, 63P3, 63P4
13	OLTC Pressure relief device		Good	-	63P5
14	Main Sudden pressure relay		Good	-	63S1, 63S2
15	OLTC Sudden pressure relay		Good	-	63S3
16	Buchholz relay (gas accumllation)		Good	Good	96B
17	Oil temperature indicator		Good	-	High:100℃
18	Winding temperature indicator (HV)		Good	-	High:120℃
19	Annunciator		Good	-	AN1, AN2
20	Tap changer synchronism control contacts		Good	-	MDU
21	49T (Eclipse Temp. Indicator)	Fans Start	-		Group1: 75℃, Group2: 80℃
		Oil Temperature	Good	Good	Alarm: -℃, Trip: -℃
		Winding Temp.	Good	Good	Alarm: -℃, Trip: -℃
		System state	Good	-	-
22	WTS	Analog Output	-	-	4~20mA (Ch. 1~4)
23	LTC (Tap changer drive)	Incomplete	Good	-	191T
		Thermal relay motor	Good	-	'49
		Off pisotion relay	Good	-	OPA / 191X
		Lockout aux. brake relay	Good	-	86XA
		On pisotion relay	Good	-	123X
		Neutral pisotion relay	Good	-	NLSX
		Raise limit relay	Good	-	172X
		Lower limit relay	Good	-	171X
		Tap position output	-	40×32 ohm, NO contacts	

Date of Test : 2013. 02. 25	Tested by : S. W. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Measurement of Auxiliary losses (Coolering system)

Serial No. 20120871TKE001

- Rated voltage & Frequency 1Φ 240V, 60 Hz (Top oil temp. : 24 ℃)

Description	Voltage (V)	Current (A)			Losses (W)
		R	S	T	
Total (32) Fans	**240**	**41.10**	**40.90**		7480.0
Group 1 (16)	240	20.70	20.60		3770.0
Group 2 (16) Fans	240	20.90	20.70		3800.0

Date of Test : 2013. 02. 24 | Tested by : S. W. Lee

B.C.T CHECK LIST

PROJ. NO. :2TKE001 TL2363 A12 R.1 672MVA

PRO.NAME. & SPEC.HDCP/AUSTIN ENERGY-DUNLAP SUBSTATION

PHASE	RATIO	BURDEN[VA]	CLASS	SERIAL NO.	REMARK
H1					
CT1	2000/1500/1200/400/5	200	C800	20124287	
CT4	2000/1500/1200/400/5	200	C800	20124290	
CT7	2000/1500/1200/400/5	45	0.3B1.8	20124293	
H2					
CT2	2000/1500/1200/400/5	200	C800	20124288	
CT5	2000/1500/1200/400/5	200	C800	20124291	
CT8	2000/1500/1200/400/5	45	0.3B1.8	20124294	
H3					
CT3	2000/1500/1200/400/5	200	C800	20124289	
CT6	2000/1500/1200/400/5	200	C800	20124292	
CT9	2000/1500/1200/400/5	45	0.3B1.8	20124295	
X1					
CT26	3200/5	12.5	1.2B0.5	20124306	
CT16	2000/1500/1200/400/5	45	0.3B1.8	20124302	
CT13	2000/1500/1200/400/5	200	C800	20124299	
CT10	2000/1500/1200/400/5	200	C800	20124296	
X2					
CT25	3200/5	12.5	1.2B0.5	20124305	
CT17	2000/1500/1200/400/5	45	0.3B1.8	20124303	
CT14	2000/1500/1200/400/5	200	C800	20124300	
CT11	2000/1500/1200/400/5	200	C800	20124297	
X3					
CT27	3200/5	12.5	1.2B0.5	20124307	
CT18	2000/1500/1200/400/5	45	0.3B1.8	20124304	
CT15	2000/1500/1200/400/5	200	C800	20124301	
CT11	2000/1500/1200/400/5	200	C800	20124398	
Y1					
CT22	5000/4000/2000/1500/5	200	C800	20124311	
CT19	7000/5	200	C800	20124308	
Y2					
CT23	5000/4000/2000/1500/5	200	C800	20124312	
CT20	7000/5	200	C800	20124309	
Y3					
CT24	5000/4000/2000/1500/5	200	C800	20124313	
CT21	7000/5	200	C800	20124310	

INSPECTION DATE : 2013.01.28 INSPECTOR :

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Bushing current transformer

Serial No. 20120871TKE001

Ratio, polarity and resistance measurement

Pri. Lead	Supply voltage(V)	BCT Lead (Cable No.)	Measured voltage(V)	Calculation voltage(V)	Rated ratio	Resistance at 28 ℃(Ω)	Polarity (subtractive)	Remark
H1 (BCT1)	200V (X1-X5)	H11X1-H11X5	200.0	200.0	2000/5A	0.704	Good	200VA C800
		H11X1-H11X4	150.2	150.0	1500/5A	0.554		
		H11X1-H11X3	120.1	120.0	1200/5A	0.465		
		H11X1-H11X2	40.1	40.0	400/5A	0.230		
H2 (BCT2)	200V (X1-X5)	H21X1-H21X5	200.2	200.0	2000/5A	0.682	Good	200VA C800
		H21X1-H21X4	150.1	150.0	1500/5A	0.532		
		H21X1-H21X3	120.2	120.0	1200/5A	0.441		
		H21X1-H21X2	40.1	40.0	400/5A	0.210		
H3 (BCT3)	200V (X1-X5)	H31X1-H31X5	200.0	200.0	2000/5A	0.666	Good	200VA C800
		H31X1-H31X4	150.1	150.0	1500/5A	0.518		
		H31X1-H31X3	120.1	120.0	1200/5A	0.429		
		H31X1-H31X2	40.2	40.0	400/5A	0.195		
H1 (BCT4)	200V (X1-X5)	H12X1-H12X5	200.2	200.0	2000/5A	0.698	Good	200VA C800
		H12X1-H12X4	150.2	150.0	1500/5A	0.549		
		H12X1-H12X3	120.1	120.0	1200/5A	0.459		
		H12X1-H12X2	40.2	40.0	400/5A	0.226		
H2 (BCT5)	200V (X1-X5)	H22X1-H22X5	200.2	200.0	2000/5A	0.682	Good	200VA C800
		H22X1-H22X4	150.1	150.0	1500/5A	0.529		
		H22X1-H22X3	120.1	120.0	1200/5A	0.439		
		H22X1-H22X2	40.2	40.0	400/5A	0.207		
H3 (BCT6)	200V (X1-X5)	H32X1-H32X5	200.0	200.0	2000/5A	0.666	Good	200VA C800
		H32X1-H32X4	150.1	150.0	1500/5A	0.515		
		H32X1-H32X3	120.1	120.0	1200/5A	0.426		
		H32X1-H32X2	40.0	40.0	400/5A	0.191		
H1 (BCT7)	200V (X1-X5)	H13X1-H13X5	200.1	200.0	2000/5A	0.498	Good	45VA 0.3B1.8
		H13X1-H13X4	150.1	150.0	1500/5A	0.393		
		H13X1-H13X3	120.2	120.0	1200/5A	0.333		
		H13X1-H13X2	40.1	40.0	400/5A	0.181		
H2 (BCT8)	200V (X1-X5)	H23X1-H23X5	200.2	200.0	2000/5A	0.473	Good	45VA 0.3B1.8
		H23X1-H23X4	150.2	150.0	1500/5A	0.374		
		H23X1-H23X3	120.1	120.0	1200/5A	0.312		
		H23X1-H23X2	40.0	40.0	400/5A	0.162		
H3 (BCT9)	200V (X1-X5)	H33X1-H33X5	200.0	200.0	2000/5A	0.455	Good	45VA 0.3B1.8
		H33X1-H33X4	150.2	150.0	1500/5A	0.361		
		H33X1-H33X3	120.1	120.0	1200/5A	0.298		
		H33X1-H33X2	40.0	40.0	400/5A	0.147		

Date of Test : 2013. 02. 21 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Bushing current transformer

Serial No. 20120871TKE001

Ratio, polarity and resistance measurement

Pri. Lead	Supply voltage(V)	BCT Lead (Cable No.)	Measured voltage(V)	Calculation voltage(V)	Rated ratio	Resistance at 28 ℃(Ω)	Polarity (subtractive)	Remark
X1 (BCT10)	200V (X1-X5)	X11X1-X11X5	200.0	200.0	2000/5A	0.760	Good	200VA C800
		X11X1-X11X4	150.1	150.0	1500/5A	0.593		
		X11X1-X11X3	120.2	120.0	1200/5A	0.495		
		X11X1-X11X2	40.1	40.0	400/5A	0.239		
X2 (BCT11)	200V (X1-X5)	X21X1-X21X5	200.2	200.0	2000/5A	0.760	Good	200VA C800
		X21X1-X21X4	150.1	150.0	1500/5A	0.592		
		X21X1-X21X3	120.1	120.0	1200/5A	0.490		
		X21X1-X21X2	40.0	40.0	400/5A	0.232		
X3 (BCT12)	200V (X1-X5)	X31X1-X31X5	200.0	200.0	2000/5A	0.738	Good	200VA C800
		X31X1-X31X4	150.0	150.0	1500/5A	0.568		
		X31X1-X31X3	120.0	120.0	1200/5A	0.470		
		X31X1-X31X2	40.0	40.0	400/5A	0.213		
X1 (BCT13)	200V (X1-X5)	X12X1-X12X5	200.1	200.0	2000/5A	0.756	Good	200VA C800
		X12X1-X12X4	150.2	150.0	1500/5A	0.592		
		X12X1-X12X3	120.1	120.0	1200/5A	0.498		
		X12X1-X12X2	40.1	40.0	400/5A	0.240		
X2 (BCT14)	200V (X1-X5)	X22X1-X22X5	200.2	200.0	2000/5A	0.742	Good	200VA C800
		X22X1-X22X4	150.0	150.0	1500/5A	0.581		
		X22X1-X22X3	120.1	120.0	1200/5A	0.479		
		X22X1-X22X2	40.2	40.0	400/5A	0.224		
X3 (BCT15)	200V (X1-X5)	X32X1-X32X5	200.2	200.0	2000/5A	0.724	Good	200VA C800
		X32X1-X32X4	150.0	150.0	1500/5A	0.562		
		X32X1-X32X3	120.2	120.0	1200/5A	0.463		
		X32X1-X32X2	40.2	40.0	400/5A	0.209		
X1 (BCT16)	200V (X1-X5)	X13X1-X13X5	200.1	200.0	2000/5A	0.415	Good	45VA 0.3B1.8
		X13X1-X13X4	150.1	150.0	1500/5A	0.336		
		X13X1-X13X3	120.0	120.0	1200/5A	0.288		
		X13X1-X13X2	40.1	40.0	400/5A	0.163		
X2 (BCT17)	200V (X1-X5)	X23X1-X23X5	200.1	200.0	2000/5A	0.403	Good	45VA 0.3B1.8
		X23X1-X23X4	150.2	150.0	1500/5A	0.318		
		X23X1-X23X3	120.2	120.0	1200/5A	0.272		
		X23X1-X23X2	40.2	40.0	400/5A	0.148		
X3 (BCT18)	200V (X1-X5)	X33X1-X33X5	200.1	200.0	2000/5A	0.383	Good	45VA 0.3B1.8
		X33X1-X33X4	150.0	150.0	1500/5A	0.307		
		X33X1-X33X3	120.1	120.0	1200/5A	0.258		
		X33X1-X33X2	40.0	40.0	400/5A	0.133		

Date of Test : 2013. 02. 21 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Bushing current transformer

Serial No. 20120871TKE001

Ratio, polarity and resistance measurement

Pri. Lead	Supply voltage(V)	BCT Lead (Cable No.)	Measured voltage(V)	Calculation voltage(V)	Rated ratio	Resistance at 28 ℃(Ω)	Polarity (subtractive)	Remark
Y1 (BCT22)	500V (X1-X5)	Y11X1-X11X5	500.1	500.0	5000/5A	1.197	Good	200VA C800
		Y11X1-X11X6	400.0	400.0	4000/5A	0.968		
		Y11X1-X11X7	200.0	200.0	2000/5A	0.540		
		Y11X1-X11X8	150.1	150.0	1500/5A	0.438		
Y2 (BCT23)	500V (X1-X5)	Y21X1-Y21X5	500.1	500.0	5000/5A	1.206	Good	200VA C800
		Y21X1-Y21X6	400.2	400.0	4000/5A	0.973		
		Y21X1-Y21X7	200.1	200.0	2000/5A	0.537		
		Y21X1-Y21X8	150.2	150.0	1500/5A	0.433		
Y3 (BCT24)	500V (X1-X5)	Y31X1-Y31X5	500.2	500.0	5000/5A	1.207	Good	200VA C800
		Y31X1-Y31X6	400.1	400.0	4000/5A	0.969		
		Y31X1-Y31X7	200.1	200.0	2000/5A	0.534		
		Y31X1-Y31X8	150.1	150.0	1500/5A	0.428		

Pri. Lead	Supply current	BCT Lead (Cable No.)	Measured current(A)	Calculation current(A)	Rated ratio	Resistance at 28 ℃(Ω)	Polarity (subtractive)	Remark
X1 (BCT26)	1882.5	X14X1-X14X2	2.940	2.940	3200/5A	0.560	Good	12.5VA 1.2B0.5 FOR WTI
X2 (BCT25)	1882.5	X24X1-X24X2	2.940	2.940	3200/5A	0.540	Good	12.5VA 1.2B0.5 FOR AVR
X3 (BCT27)	1882.5	X34X1-X34X2	2.940	2.940	3200/5A	0.525	Good	12.5VA 1.2B0.5 FOR ETM
Y1 (BCT19)	2071.3	Y12X1-Y12X2	1.460	1.480	7000/5A	1.475	Good	200VA C800
Y2 (BCT20)	2071.3	Y22X1-Y22X2	1.460	1.480	7000/5A	1.482	Good	200VA C800
Y3 (BCT21)	2071.3	Y32X1-Y32X2	1.460	1.480	7000/5A	1.482	Good	200VA C800

Date of Test : 2013. 02. 21 | Tested by : J. C. Song

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

On-load tap changer test

Serial No.
20120871TKE001

	Results
1. Visual inspection	Satisfactory
2. Operation test	Satisfactory

a) 8 Complete operating cycle with the transformer not energized.

b) 1 Complete operating cycle with the transformer energized at the rated voltage and frequency at no-load

c) 10 Tap changer operation with ±2 steps on either side of reversing tapping with as far as possible rated current.

d) 1 Complete operating cycle with the transformer not energized with 85% of the rated auxiliary supply voltage.

3. Insulation test of control unit	Withstood

a) Insulation resistance measurement with 1000V megger tester a 22 ℃ 450 MΩ

b) Power frequency withstand test of 2000V for 1 min

4. Insulation resistance measurement of OLTC with 5000V megger	Withstood

at 22 ℃ 6510 MΩ

5. Sequence test	Satisfactory

a) Step by step operation test

b) Tap lower limit check

c) Tap indicator operation test

d) Magnet contactor operation test

e) All switch operation test

Date of Test : 2013. 02. 21	Tested by : S. W. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

No-load tap changer test

Serial No.
20120871TKE001

	Results
1. Visual inspection	Satisfactory
2. Operation test	
The off load tap changer was operated by hand and proved.	Satisfactory

Date of Test :	2013. 02. 21	Tested by :	S. W. Lee

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Oil leakage test

Serial No.
20120871TKE001

One transformer tank with other fittings and conservator were over pressured to normal pressure plus 0.35 kg/cm^2 for 14 hours.

After this test, the compiete transformer with accessories proved no leaks.

All final results are as follows;

Test result : Passed

Date of Test : 2013. 02. 20~21	Tested by : Y. D. Choi

HYUNDAI HEAVY INDUSTRIES CO.,LTD.

Final dimension check list

Serial No.
20120871TKE001

1. Construction check (Visual) : Passed

2. Dimension check : Passed

Tolerance : ±2%

No.	Description		Spec. (inch)	Measured value (inch)	Remarks
1	Length of transformer		621.3	622	
2	Width of transformer		311.4	311.8	
3	Height of transformer		347.8	348.1	
4	Distance between HV bushings		144.6	144.8	
5	Distance between LV bushings		82.7	83	
6	Distance between TV bushings		23	23.1	
7	Distance between anchor holes	Length	N/A	N/A	
		Width	N/A	N/A	
8	Size of anchor hole		N/A	N/A	
9	Height of HV bushing		347.8	348.1	
10	Height of LV bushing		273.1	273.6	
11	Height of TV bushing		204	204.2	

3. Paint colour & thickness check : Passed

1) Paint Colour = Spec. : ANSI No. 70 Result : ANSI No. 70

2) Paint thickness = Spec. : ≥ 150 ㎛ Result : 178 ~ 195 ㎛

Date of Test : 2013. 02. 21	Tested by : Y. D. Choi

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

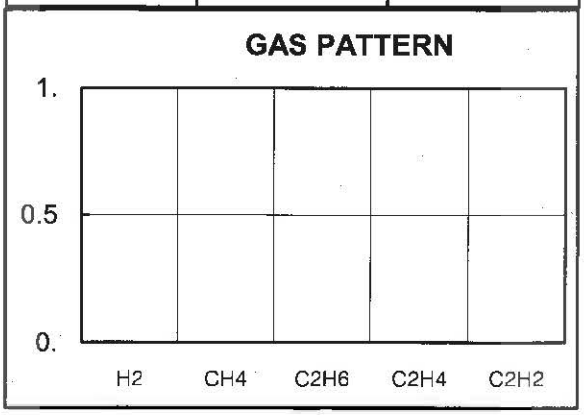
GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

REPORT No. : W640-A1302-309-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : Before tests
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-21
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-25

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	0.0
2	METHANE	CH4	≤ 5	> 5	0.1
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	1438.0
7	NITROGEN	N2	-	-	5796.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	2.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	28.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	2.1
13	TOTAL GAS CONTENT		-	-	7264.1

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

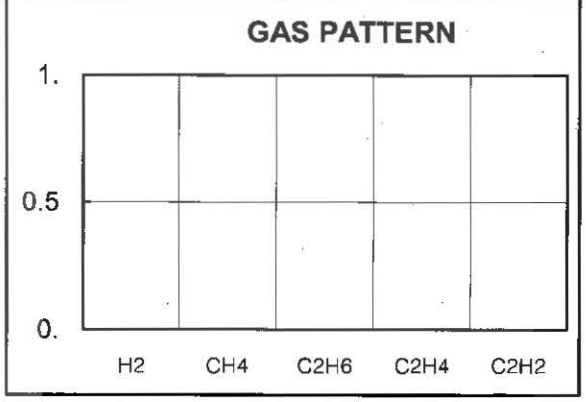
GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

REPORT No. : W640-A1302-310-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : After load loss test
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-22
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-25

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	0.0
2	METHANE	CH4	≤ 5	> 5	0.1
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	1502.0
7	NITROGEN	N2	-	-	5880.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	2.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	30.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	2.1
13	TOTAL GAS CONTENT		-	-	7414.1

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

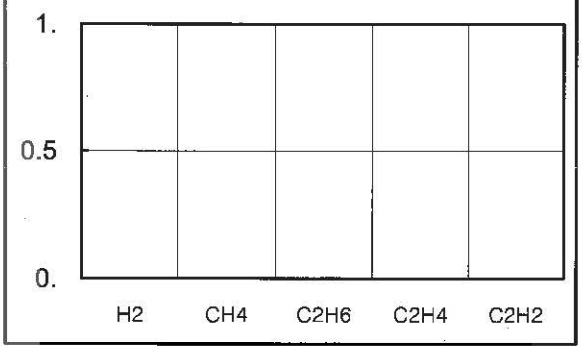
REPORT No. : W640-A1302-311-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : After temp. rise test (ONAN)
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-23
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-25

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ppm CRITERIA ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	2.0
2	METHANE	CH4	≤ 5	> 5	0.1
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	1160.0
7	NITROGEN	N2	-	-	4838.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	6.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	43.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	8.1
13	TOTAL GAS CONTENT		-	-	6049.1

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		

GAS PATTERN



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

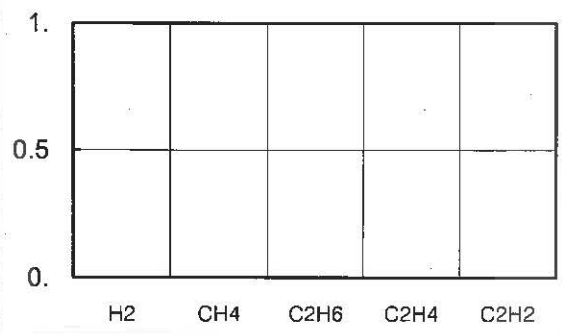
REPORT No. : W640-A1302-312-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : After temp. rise test (ONAF2)
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-23
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-25

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	2.0
2	METHANE	CH4	≤ 5	> 5	0.2
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	1444.0
7	NITROGEN	N2	-	-	6025.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	10.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	70.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	12.2
13	TOTAL GAS CONTENT		-	-	7551.2

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		

GAS PATTERN



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

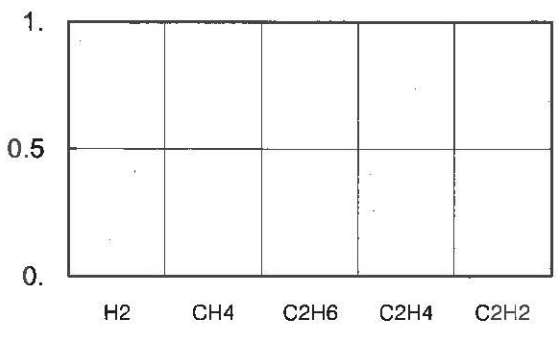
REPORT No. : W640-A1302-360-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : After temp, rise test(After 8hr)
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-24
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-26

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ppm CRITERIA ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	1.0
2	METHANE	CH4	≤ 5	> 5	0.2
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	2015.0
7	NITROGEN	N2	-	-	7811.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	11.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	80.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	12.2
13	TOTAL GAS CONTENT		-	-	9918.2

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		

GAS PATTERN



REMARK

The test results solely based on the sample(s) submitted to SLR. can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

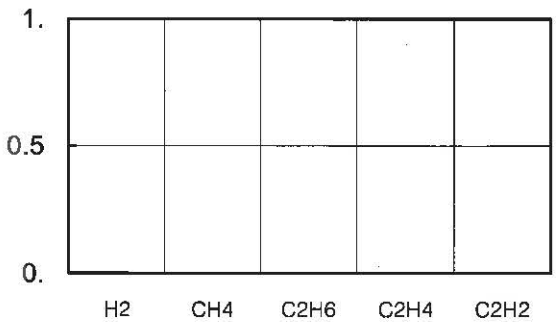
REPORT No. : W640-A1302-361-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : After impulse test
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-24
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-26

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ppm CRITERIA ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	1.0
2	METHANE	CH4	≤ 5	> 5	0.2
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	1646.0
7	NITROGEN	N2	-	-	6695.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	12.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	75.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	13.2
13	TOTAL GAS CONTENT		-	-	8429.2

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		

GAS PATTERN



REMARK

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Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

△ HYUNDAI HEAVY INDUSTRIES CO., LTD.

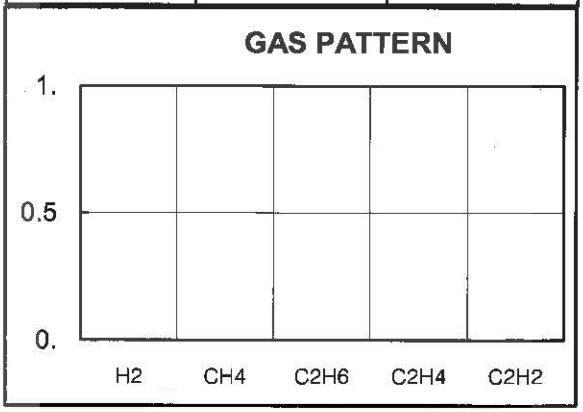
GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

REPORT No. : W640-A1302-362-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : After induced voltage test
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-25
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-26

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ppm CRITERIA ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	1.0
2	METHANE	CH4	≤ 5	> 5	0.2
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	2226.0
7	NITROGEN	N2	-	-	8993.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	13.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	85.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	14.2
13	TOTAL GAS CONTENT		-	-	11318.2

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

HYUNDAI HEAVY INDUSTRIES CO., LTD.

GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

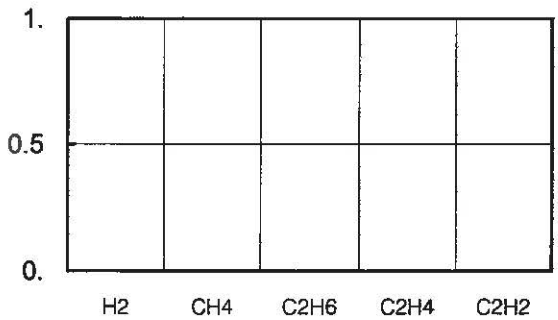
REPORT No. : W640-A1302-377-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : Before110% over excitation test
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-26
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-28

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ppm CRITERIA ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	2.0
2	METHANE	CH4	≤ 5	> 5	0.2
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	2435.0
7	NITROGEN	N2	-	-	9402.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	13.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	85.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	15.2
13	TOTAL GAS CONTENT		-	-	11937.2

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		

GAS PATTERN



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

HYUNDAI HEAVY INDUSTRIES CO., LTD.

GAS ANALYSIS OF DISSOLVED GAS IN TR. OIL

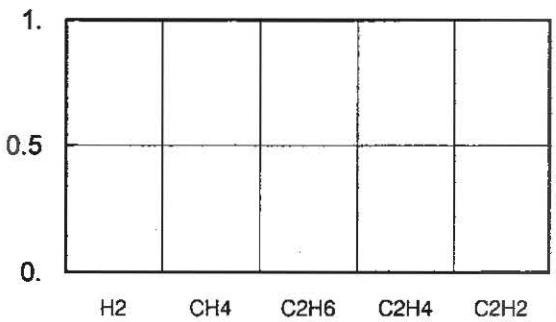
REPORT No. : W640-A1302-382-1
CUSTOMER : AUSTIN ENERGY-DUNLAP SUBSTATIO
TR. No. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
PROCESS : The end of over excitation test(8hr)
REQUESTED BY : ELECTRO ELECTRIC SYSTEMS QM 400KV LAB.
Sampling Date : 2013-02-27
Test Method : ASTM D 3612

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
Standard Laboratory Room
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202-8256
Fax : (052) 250-9939
Test Date: 2013-02-28

NO	UNIT / STAGE / GAS		ppm CRITERIA NORMAL	ppm CRITERIA ABNORMAL	RESULT
1	HYDROGEN	H2	≤ 15	> 15	2.0
2	METHANE	CH4	≤ 5	> 5	0.2
3	ETHANE	C2H6	≤ 5	> 5	0.0
4	ETHYLENE	C2H4	≤ 4	> 4	0.0
5	ACETYLENE	C2H2	It needs caution for any trace		0.0
6	OXYGEN	O2	-	-	1815.0
7	NITROGEN	N2	-	-	6918.0
8	CARBON MONOXIDE	CO	≤ 25	> 25	14.0
9	CARBON DIOXIDE	CO2	≤ 150	> 150	79.0
10	PROPANE-PROPYLENE	C3H8/C3H6	FOR REFERENCE ONLY		0.0
11	I-BUTAN	i-C4H10	FOR REFERENCE ONLY		0.0
12	TOTAL COMBUSTIBLE GAS		≤ 55	> 55	16.2
13	TOTAL GAS CONTENT		-	-	8828.2

STAGE / GAS	RATIO	CODE No.
C2H2 / C2H4		
CH4 / H2		
C2H4 / C2H6		

GAS PATTERN



REMARK

The test results solely based on the sample(s) submitted to SLR, can be used for the specified purpose.

Tested by: Y. W. NAM

Approved by: J. H. PARK
General Manager

HYUNDAI HEAVY INDUSTRIES CO., LTD.

TEST REPORT

REPORT No. : W640-A1302-112-1
NOMENCLATURE : Insulating oil
MATERIAL : IEC 60296 (2003)
CUSTOMER : HDCP(USA)
PROJ. NO. : 20120871TKE001
SPEC. : 345/138/13.2kV 400/530/672MVA
REQUESTED BY : 전기전자시스템 400kV TR TEST LAB.

ELECTRO ELECTRIC SYSTEMS
QUALITY MANAGEMENT DEPARTMENT
1000, Bangeojinsunhwan-doro, Dong-Gu Ulsan Korea
Tel.: (052) 202 - 8256
Fax : (052) 250 - 9939
Test Date: 2013-02-25
Sampling Date: 2013-02-21

TEST RESULT

TEST ITEM	SPEC.	RESULT	TEST METHOD
Moisture content ppm	30 Max	4	IEC 60814
Dielectric strength 2.5 mm kV	30 Min	72	IEC 60156
Power Factor test at 90 ℃	0.005 Max	0.0012	IEC 60247
Particle counter test	Reference Value	3	NAS 1638

※ The test results solely based on the sample(s) submitted to SLR, can not be used for the specified purpose.

REMARK
Before test

Tested by: E. Y. KIM

Approved by: J. H. PARK
General Manager

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008082(VZC-1284)

PROJ. No. : 20120871TKE001

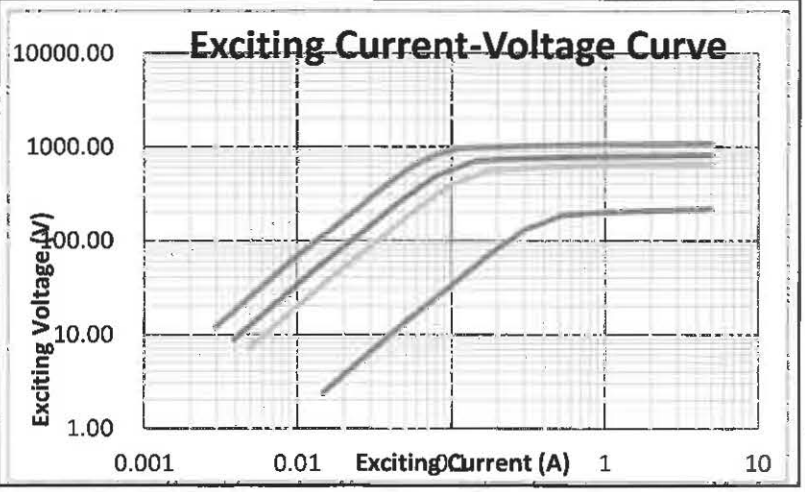
Class : C800 - - -

Burden : 200 VA

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124287				EXCITING CURRENT CHARACTERISTIC TEST									
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A	Measuring Voltage(V)	11.7	64.7	177.9	358.2	651.9	936.3	1001.0	1036.0	1085.4
	X1-X5	X1-X4	X1-X3	X1-X2	Measuring Current(A)	0.0029	0.010	0.021	0.036	0.060	0.11	0.22	0.43	5.00
1. Visual check	GOOD				Measuring Voltage(V)	8.8	48.5	133.4	268.6	489.0	702.2	750.8	777.0	814.1
2. Rct at . secondary wdg 15.9 ℃	0.565	0.674	0.345	0.124	Measuring Current(A)	0.0039	0.013	0.028	0.048	0.079	0.14	0.29	0.58	5.00
3. Secondary winding resistance at 75℃ (Rs)	0.698	0.833	0.426	0.153	Measuring Voltage(V)	7.0	38.8	106.8	214.9	391.2	561.8	600.6	621.6	651.2
4. Rated burden impedance (Zb)	8.371	6.457	5.027	1.682	Measuring Current(A)	0.0049	0.016	0.035	0.060	0.099	0.18	0.37	0.72	5.00
5. Rated accuracy Limit current (IASA)	100	100	100	100	Measuring Voltage(V)	2.3	12.9	35.6	71.6	130.4	187.3	200.2	207.2	217.1
6. Exciting voltage (Es)	837.09	645.68	502.67	168.18	Measuring Current(A)	0.0147	0.049	0.106	0.179	0.298	0.54	1.10	2.17	5.00
7. Exciting current (Ie)	0.081	0.108	0.135	0.406										
8. Composite error(%)	0.081	0.108	0.135	0.406										
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.136	-0.216	-0.333	-2.199										
10. Polarity test	Subtractive													
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood													
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood													
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory													



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008082(VZC-1284)

PROJ. No. : 20120871TKE001

Class : C800 - - -

Burden : 200 VA

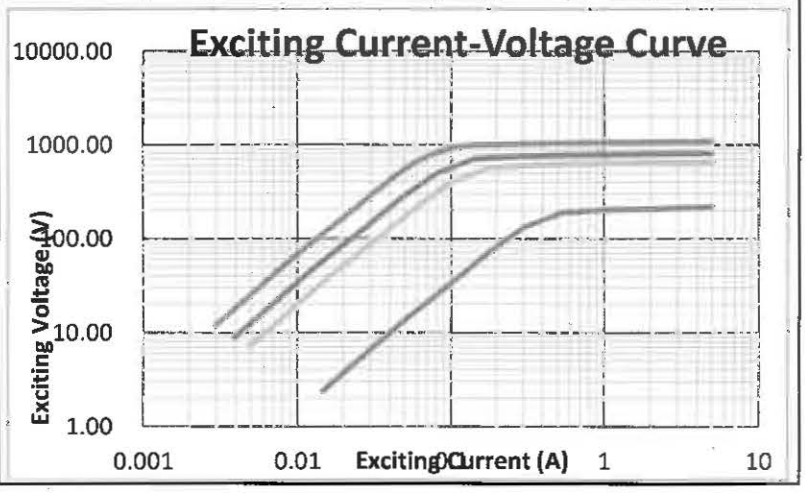
C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124288			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 15.9 ℃	0.562	0.427	0.343	0.124
3. Secondary winding resistance at 75℃ (Rs)	0.695	0.528	0.424	0.153
4. Rated burden impedance (Zb)	8.369	6.280	5.025	1.682
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	836.88	628.04	502.53	168.18
7. Exciting current (Ie)	0.078	0.104	0.130	0.390
8. Composite error(%)	0.078	0.104	0.130	0.390
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.157	-0.293	-0.362	-2.175
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	11.7	65.2	178.2	359.2	652.2	940.2	1008.2	1038.3	1086.4
Measuring Current(A)	0.0029	0.010	0.021	0.036	0.060	0.11	0.22	0.43	5.00
Measuring Voltage(V)	8.8	48.9	133.6	269.4	489.1	705.1	756.1	778.7	814.8
Measuring Current(A)	0.0039	0.013	0.028	0.048	0.079	0.14	0.29	0.58	5.00
Measuring Voltage(V)	7.0	39.1	106.9	215.5	391.3	564.1	604.9	623.0	651.8
Measuring Current(A)	0.0049	0.016	0.035	0.060	0.099	0.18	0.37	0.72	5.00
Measuring Voltage(V)	2.3	13.0	35.6	71.8	130.4	188.0	201.6	207.7	217.3
Measuring Current(A)	0.0147	0.049	0.106	0.179	0.298	0.54	1.10	2.17	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Current Transformer Certificate

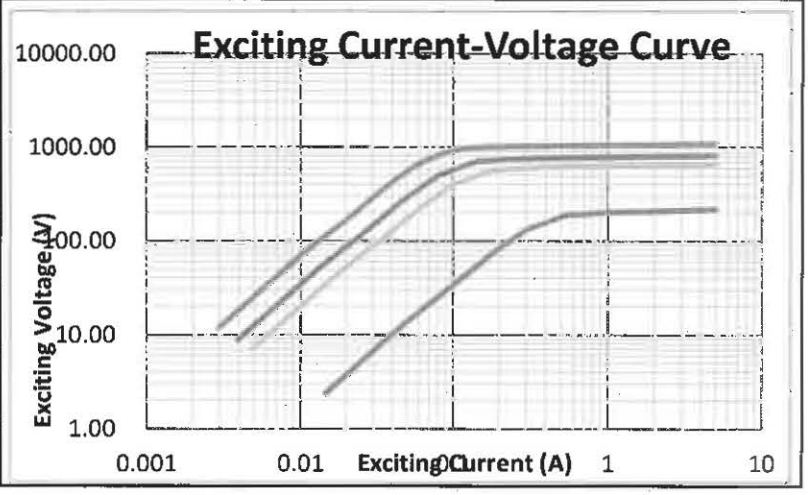
TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE	: 5123008082(VZC-1284)	PROJ. No.	: 20120871TKE001
Class	: C800 - - -	Burden	: 200 VA
C.T Ratio	: 2000 - 1500 - 1200 - 400 / 5A	Frequency	: 60 Hz

SERIAL NO.	CA20124289			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 15.9 °C	0.564	0.428	0.344	0.125
3. Secondary winding resistance at 75°C (Rs)	0.697	0.529	0.425	0.155
4. Rated burden impedance (Zb)	8.370	6.281	5.026	1.683
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	837.02	628.11	502.60	168.25
7. Exciting current (Ie)	0.076	0.101	0.127	0.380
8. Composite error(%)	0.076	0.101	0.127	0.380
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.158	-0.302	-0.364	-2.218
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST									
Measuring Voltage(V)	11.7	66.3	179.1	362.2	655.2	940.2	1011.2	1033.1	1084.2
Measuring Current(A)	0.0029	0.010	0.021	0.036	0.060	0.11	0.22	0.43	5.00
Measuring Voltage(V)	8.8	49.7	134.3	271.6	491.4	705.1	758.4	774.8	813.1
Measuring Current(A)	0.0039	0.013	0.028	0.048	0.079	0.14	0.29	0.58	5.00
Measuring Voltage(V)	7.0	39.8	107.5	217.3	393.1	564.1	606.7	619.9	650.5
Measuring Current(A)	0.0049	0.016	0.035	0.060	0.099	0.18	0.37	0.72	5.00
Measuring Voltage(V)	2.3	13.3	35.8	72.4	131.0	188.0	202.2	206.6	216.8
Measuring Current(A)	0.0147	0.049	0.106	0.179	0.298	0.54	1.10	2.17	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008082(VZC-1284)

PROJ. No. : 20120871TKE001

Class : C800 - - -

Burden : 200 VA

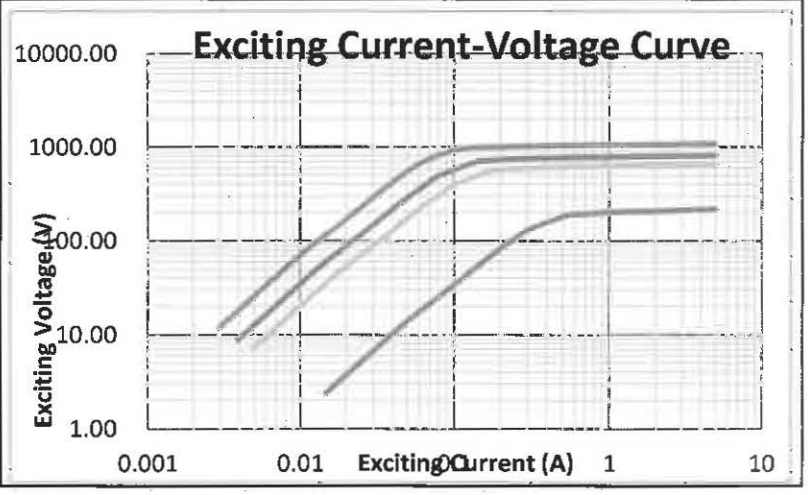
C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124290			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 15.9 ℃	0.562	0.427	0.343	0.124
3. Secondary winding resistance at 75℃ (Rs)	0.695	0.528	0.424	0.153
4. Rated burden impedance (Zb)	8.369	6.280	5.025	1.682
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	836.88	628.04	502.53	168.18
7. Exciting current (Ie)	0.077	0.103	0.128	0.385
8. Composite error(%)	0.077	0.103	0.128	0.385
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.139	-0.234	-0.376	-2.208
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	11.7	67.1	180.3	360.5	655.2	942.7	1009.2	1036.3	1086.3
Measuring Current(A)	0.0029	0.010	0.021	0.036	0.060	0.11	0.22	0.43	5.00
Measuring Voltage(V)	8.8	50.3	135.2	270.4	491.4	707.0	756.9	777.2	814.7
Measuring Current(A)	0.0039	0.013	0.028	0.048	0.079	0.14	0.29	0.58	5.00
Measuring Voltage(V)	7.0	40.3	108.2	216.3	393.1	565.6	605.5	621.8	651.8
Measuring Current(A)	0.0049	0.016	0.035	0.060	0.099	0.18	0.37	0.72	5.00
Measuring Voltage(V)	2.3	13.4	36.1	72.1	131.0	188.5	201.8	207.3	217.3
Measuring Current(A)	0.0147	0.049	0.106	0.179	0.298	0.54	1.10	2.17	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008082(VZC-1284)

PROJ. No. : 20120871TKE001

Class : C800 - - -

Burden : 200 VA

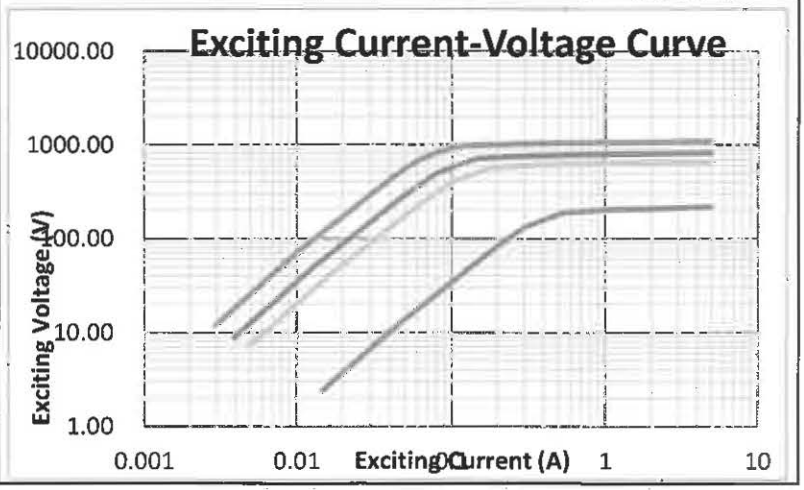
C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124291			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 15.9 °C	0.562	0.427	0.343	0.124
3. Secondary winding resistance at 75°C (Rs)	0.695	0.528	0.424	0.153
4. Rated burden impedance (Zb)	8.369	6.280	5.025	1.682
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	836.88	628.04	502.53	168.18
7. Exciting current (Ie)	0.077	0.103	0.128	0.385
8. Composite error(%)	0.077	0.103	0.128	0.385
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.139	-0.234	-0.376	-2.208
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	11.7	66.3	182.4	361.3	657.2	943.4	1011.3	1037.2	1088.3
Measuring Current(A)	0.0029	0.010	0.021	0.036	0.060	0.11	0.22	0.43	5.00
Measuring Voltage(V)	8.8	49.7	136.8	270.9	492.9	707.5	758.4	777.9	816.2
Measuring Current(A)	0.0039	0.013	0.028	0.048	0.079	0.14	0.29	0.58	5.00
Measuring Voltage(V)	7.0	39.8	109.4	216.8	394.3	566.0	606.8	622.3	653.0
Measuring Current(A)	0.0049	0.016	0.035	0.060	0.099	0.18	0.37	0.72	5.00
Measuring Voltage(V)	2.3	13.3	36.5	72.3	131.4	188.7	202.3	207.4	217.7
Measuring Current(A)	0.0147	0.049	0.106	0.179	0.298	0.54	1.10	2.17	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008082(VZC-1284)

PROJ. No. : 20120871TKE001

Class : C800 - - -

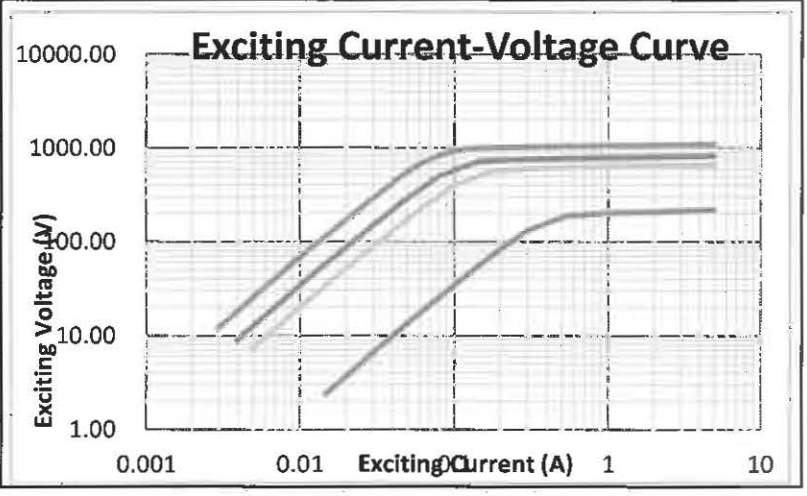
Burden : 200 VA

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124292			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 15.9 ℃	0.563	0.428	0.344	0.124
3. Secondary winding resistance at 75℃ (Rs)	0.696	0.529	0.425	0.153
4. Rated burden impedance (Zb)	8.369	6.281	5.026	1.682
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	836.95	628.11	502.60	168.18
7. Exciting current (Ie)	0.078	0.104	0.130	0.390
8. Composite error(%)	0.078	0.104	0.130	0.390
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.133	-0.212	-0.331	-2.205
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST									
Measuring Voltage(V)	11.7	65.2	183.1	362.1	658.2	944.4	1008.2	1036.3	1089.3
Measuring Current(A)	0.0029	0.010	0.021	0.036	0.060	0.11	0.22	0.43	5.00
Measuring Voltage(V)	8.8	48.9	137.3	271.5	493.7	708.3	756.1	777.2	816.9
Measuring Current(A)	0.0039	0.013	0.028	0.048	0.079	0.14	0.29	0.58	5.00
Measuring Voltage(V)	7.0	39.1	109.9	217.2	394.9	566.6	604.9	621.8	653.6
Measuring Current(A)	0.0049	0.016	0.035	0.060	0.099	0.18	0.37	0.72	5.00
Measuring Voltage(V)	2.3	13.0	36.6	72.4	131.6	188.9	201.6	207.3	217.9
Measuring Current(A)	0.0147	0.049	0.106	0.179	0.298	0.54	1.10	2.17	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

NO. 1212CA20124293

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE ;	5123008083(VZC-1285)	Project No. ;	20120871TKE001
Accuracy Class ;	0.3B-1.8	Pri.current ;	2000-1500-1200-400 A
Burden ;	45 VA	Sec.current ;	5 A
Serial No. ;	CA20124293	Frequency ;	60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Current / Burden		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	45 VA	±0.3	±0.6	±15.6	±31.2	1±0.003	1±0.006	1±0.003	1±0.006	
2000/5 A	45 VA	-0.113	-0.162	1.83	3.30	1.00113	1.00162	1.00043	1.00035	0.442 Ω
1500/5 A	45 VA	-0.186	-0.259	2.95	5.10	1.00186	1.00260	1.00073	1.00064	0.338 Ω
1200/5 A	45 VA	-0.261	-0.360	4.27	7.21	1.00262	1.00361	1.00097	1.00084	0.272 Ω
400/5 A	45 VA	-1.670	-2.240	22.86	44.11	1.01698	1.02291	1.00819	1.00595	0.102 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : IEEE C57. 13,

Temperature 16.2 ℃ Humidity 27 %

Date 2012, 12 . 28

Tested by : J. H. KIM Reviewed by : J. Y. SIM

NO. 1212CA20124294

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE	; 5123008083(VZC-1285)	Project No.	; 20120871TKE001
Accuracy Class	; 0.3B-1.8	Pri.current	; 2000-1500-1200-400 A
Burden	; 45 VA	Sec.current	; 5 A
Serial No.	; CA20124294	Frequency	; 60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Burden \ Current		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	45 VA	±0.3	±0.6	±15.6	±31.2	1±0.003	1±0.006	1±0.003	1±0.006	
2000/5 A	45 VA	-0.113	-0.151	2.09	3.79	1.00113	1.00151	1.00033	1.00005	0.442 Ω
1500/5 A	45 VA	-0.192	-0.250	3.31	5.92	1.00192	1.00251	1.00065	1.00023	0.338 Ω
1200/5 A	45 VA	-0.248	-0.331	4.73	8.39	1.00249	1.00332	1.00067	1.00009	0.272 Ω
400/5 A	45 VA	-1.601	-2.136	26.67	51.82	1.01627	1.02183	1.00601	1.00190	0.102 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : **IEEE C57. 13,**

Temperature 16.2 ℃ Humidity 27 %

Date 2012, 12 . 28

Tested by : J. H. KIM Reviewed by : J. Y. SIM

NO. 1212CA20124295

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE	; 5123008083(VZC-1285)	Project No.	; 20120871TKE001
Accuracy Class	; 0.3B-1.8	Pri.current	; 2000-1500-1200-400 A
Burden	; 45 VA	Sec.current	; 5 A
Serial No.	; CA20124295	Frequency	; 60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Burden \ Current		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	45 VA	±0.3	±0.6	±15.6	±31.2	1±0.003	1±0.006	1±0.003	1±0.006	
2000/5 A	45 VA	-0.129	-0.167	2.13	3.89	1.00129	1.00167	1.00047	1.00018	0.442 Ω
1500/5 A	45 VA	-0.202	-0.262	3.36	6.06	1.00202	1.00263	1.00073	1.00030	0.338 Ω
1200/5 A	45 VA	-0.249	-0.335	4.77	8.56	1.00250	1.00336	1.00066	1.00007	0.272 Ω
400/5 A	45 VA	-1.626	-2.167	26.89	52.89	1.01653	1.02215	1.00619	1.00181	0.102 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : IEEE C57. 13,

Temperature 16.2 ℃ Humidity 27 %

Date 2012, 12 . 28

Tested by : J. H. KIM Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008084(VZC-1286)

Class : C800 - - -

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

PROJ. No. : 20120871TKE001

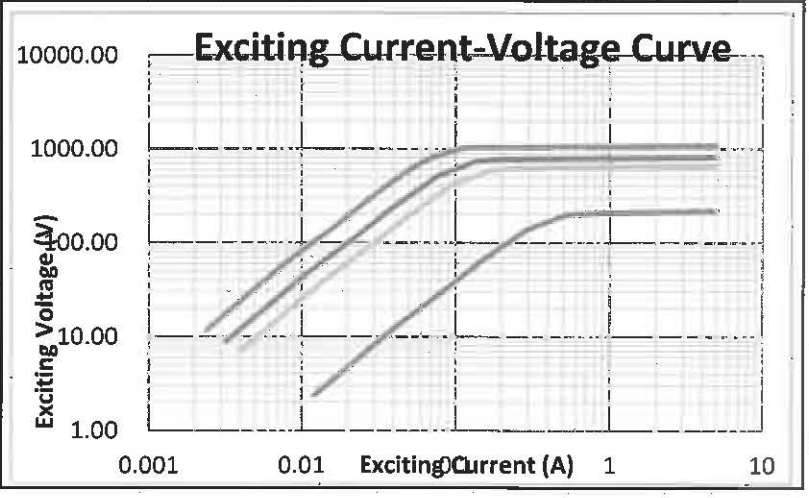
Burden : 200 VA

Frequency : 60 Hz

SERIAL NO.	CA20124296			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at secondary wdg 15.9 °C	0.611	0.464	0.373	0.134
3. Secondary winding resistance at 75°C (Rs)	0.755	0.574	0.461	0.166
4. Rated burden impedance (Zb)	8.403	6.306	5.046	1.689
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	840.29	630.62	504.62	168.89
7. Exciting current (Ie)	0.074	0.099	0.123	0.370
8. Composite error(%)	0.074	0.099	0.123	0.370
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.116	-0.151	-0.195	-0.579
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	11.8	62.2	143.1	316.0	686.8	980.1	1030.8	1041.5	1086.2
Measuring Current(A)	0.0024	0.008	0.016	0.030	0.058	0.10	0.15	0.26	5.00
Measuring Voltage(V)	8.8	46.7	107.3	237.0	515.1	735.1	773.1	781.1	814.7
Measuring Current(A)	0.0032	0.011	0.021	0.040	0.078	0.14	0.20	0.35	5.00
Measuring Voltage(V)	7.1	37.3	85.9	189.6	412.1	588.1	618.5	624.9	651.7
Measuring Current(A)	0.0041	0.014	0.027	0.050	0.097	0.17	0.25	0.44	5.00
Measuring Voltage(V)	2.4	12.4	28.6	63.2	137.4	196.0	206.2	208.3	217.2
Measuring Current(A)	0.0122	0.041	0.081	0.149	0.291	0.52	0.76	1.32	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008084(VZC-1286)

PROJ. No. : 20120871TKE001

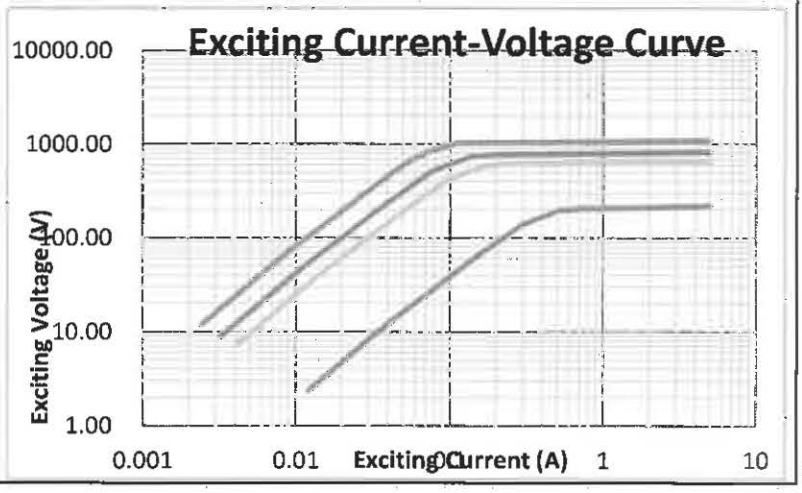
Class : C800 - - -

Burden : 200 VA

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124297				EXCITING CURRENT CHARACTERISTIC TEST									
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A	Measuring Voltage(V)	11.8	62.3	144.2	311.2	685.2	981.3	1029.2	1038.2	1087.2
	X1-X5	X1-X4	X1-X3	X1-X2	Measuring Current(A)	0.0024	0.008	0.016	0.030	0.058	0.10	0.15	0.26	5.00
1. Visual check	GOOD				Measuring Voltage(V)	8.8	46.7	108.1	233.4	513.9	735.9	771.9	778.6	815.4
2. Rct at . secondary wdg 15.9 ℃	0.623	0.473	0.380	0.136	Measuring Current(A)	0.0032	0.011	0.021	0.040	0.078	0.14	0.20	0.35	5.00
3. Secondary winding resistance at 75℃ (Rs)	0.770	0.585	0.470	0.168	Measuring Voltage(V)	7.1	37.4	86.5	186.7	411.1	588.8	617.5	622.9	652.3
4. Rated burden impedance (Zb)	8.411	6.313	5.051	1.690	Measuring Current(A)	0.0041	0.014	0.027	0.050	0.097	0.17	0.25	0.44	5.00
5. Rated accuracy Limit current (IASA)	100	100	100	100	Measuring Voltage(V)	2.4	12.5	28.8	62.2	137.0	196.3	205.8	207.6	217.4
6. Exciting voltage (Es)	841.13	631.25	505.11	169.03	Measuring Current(A)	0.0122	0.041	0.081	0.149	0.291	0.52	0.76	1.32	5.00
7. Exciting current (Ie)	0.075	0.100	0.125	0.375										
8. Composite error(%)	0.075	0.100	0.125	0.375										
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.150	-0.216	-0.248	-0.648										
10. Polarity test	Subtractive													
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood													
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood													
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory													



4. Rated burden impedance : VA / IS^2

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD

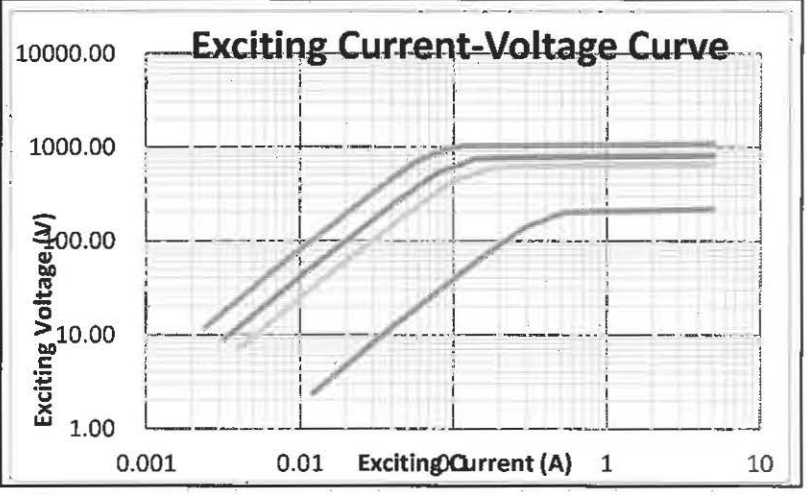
Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE	: 5123008084(VZC-1286)	PROJ. No.	: 20120871TKE001
Class	: C800 - - -	Burden	: 200 VA
C.T Ratio	: 2000 - 1500 - 1200 - 400 / 5A	Frequency	: 60 Hz

SERIAL NO.	CA20124298				EXCITING CURRENT CHARACTERISTIC TEST									
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A	Measuring Voltage(V)	11.8	61.3	144.3	316.2	694.2	984.2	1025.2	1037.2	1085.2
	X1-X5	X1-X4	X1-X3	X1-X2	Measuring Current(A)	0.0024	0.008	0.016	0.030	0.058	0.10	0.15	0.26	5.00
1. Visual check	GOOD				Measuring Voltage(V)	8.8	45.9	108.2	237.1	520.6	738.1	768.9	777.9	813.9
2. Rct at . secondary wdg 15.9 ℃	0.613	0.465	0.374	0.134	Measuring Current(A)	0.0032	0.011	0.021	0.040	0.078	0.14	0.20	0.35	5.00
3. Secondary winding resistance at 75℃ (Rs)	0.758	0.575	0.462	0.166	Measuring Voltage(V)	7.1	36.8	86.6	189.7	416.5	590.5	615.1	622.3	651.1
4. Rated burden impedance (Zb)	8.404	6.307	5.047	1.689	Measuring Current(A)	0.0041	0.014	0.027	0.050	0.097	0.17	0.25	0.44	5.00
5. Rated accuracy Limit current (IASA)	100	100	100	100	Measuring Voltage(V)	2.4	12.3	28.9	63.2	138.8	196.8	205.0	207.4	217.0
6. Exciting voltage (Es)	840.43	630.69	504.69	168.89	Measuring Current(A)	0.0122	0.041	0.081	0.149	0.291	0.52	0.76	1.32	5.00
7. Exciting current (Ie)	0.079	0.105	0.132	0.395										
8. Composite error(%)	0.079	0.105	0.132	0.395										
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.140	-0.190	-0.230	-0.647										
10. Polarity test	Subtractive													
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood													
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood													
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory													



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008084(VZC-1286)

PROJ. No. : 20120871TKE001

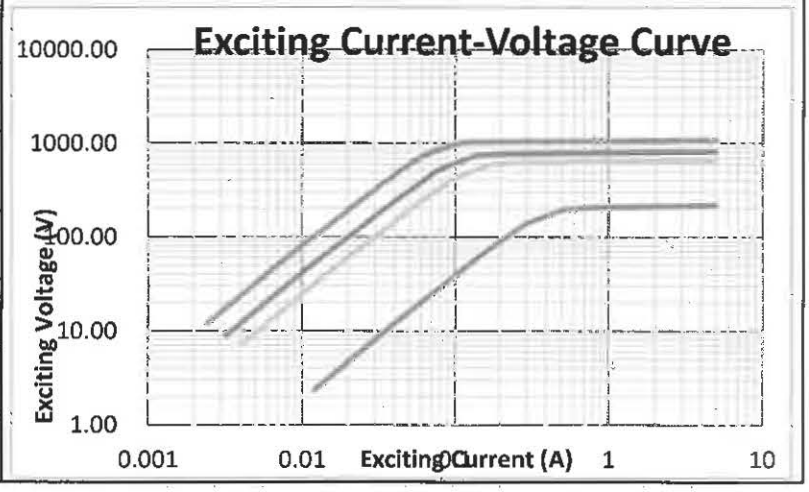
Class : C800 - - -

Burden : 200 VA

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124299				EXCITING CURRENT CHARACTERISTIC TEST									
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A	Measuring Voltage(V)	11.8	61.4	144.3	316.2	687.2	977.2	1028.2	1039.7	1085.2
	X1-X5	X1-X4	X1-X3	X1-X2	Measuring Current(A)	0.0024	0.008	0.016	0.030	0.058	0.10	0.15	0.26	5.00
1. Visual check	GOOD				Measuring Voltage(V)	8.8	46.0	108.2	237.1	515.4	732.9	771.1	779.8	813.9
2. Rct at . secondary wdg 15.9 ℃	0.610	0.463	0.372	0.134	Measuring Current(A)	0.0032	0.011	0.021	0.040	0.078	0.14	0.20	0.35	5.00
3. Secondary winding resistance at 75℃ (Rs)	0.754	0.572	0.460	0.166	Measuring Voltage(V)	7.1	36.8	86.6	189.7	412.3	586.3	616.9	623.8	651.1
4. Rated burden impedance (Zb)	8.402	6.306	5.046	1.689	Measuring Current(A)	0.0041	0.014	0.027	0.050	0.097	0.17	0.25	0.44	5.00
5. Rated accuracy Limit current (IASA)	100	100	100	100	Measuring Voltage(V)	2.4	12.3	28.9	63.2	137.4	195.4	205.6	207.9	217.0
6. Exciting voltage (Es)	840.22	630.55	504.55	168.89	Measuring Current(A)	0.0122	0.041	0.081	0.149	0.291	0.52	0.76	1.32	5.00
7. Exciting current (Ie)	0.075	0.100	0.125	0.375										
8. Composite error(%)	0.075	0.100	0.125	0.375										
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.129	-0.181	-0.209	-0.590										
10. Polarity test	Subtractive													
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood													
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood													
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory													



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO. LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008084(VZC-1286)

Class : C800 - - -

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

PROJ. No. : 20120871TKE001

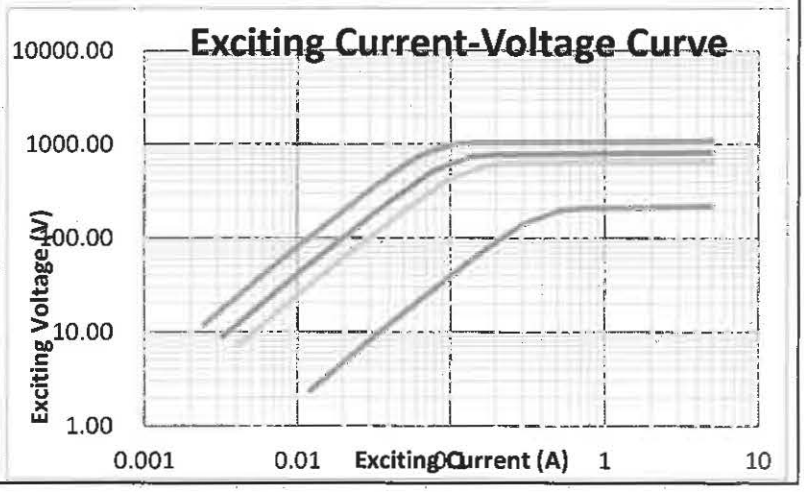
Burden : 200 VA

Frequency : 60 Hz

SERIAL NO.	CA20124300			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 15.9 ℃	0.611	0.464	0.373	0.134
3. Secondary winding resistance at 75℃ (Rs)	0.755	0.574	0.461	0.166
4. Rated burden impedance (Zb)	8.403	6.306	5.046	1.689
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	840.29	630.62	504.62	168.89
7. Exciting current (Ie)	0.077	0.103	0.128	0.385
8. Composite error(%)	0.077	0.103	0.128	0.385
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.119	-0.145	-0.197	-0.606
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	11.8	61.3	144.7	316.2	687.2	981.2	1033.2	1039.2	1084.2
Measuring Current(A)	0.0024	0.008	0.016	0.030	0.058	0.10	0.15	0.26	5.00
Measuring Voltage(V)	8.8	45.9	108.5	237.2	515.4	735.9	774.9	779.4	813.1
Measuring Current(A)	0.0032	0.011	0.021	0.040	0.078	0.14	0.20	0.35	5.00
Measuring Voltage(V)	7.1	36.8	86.8	189.7	412.3	588.7	619.9	623.5	650.5
Measuring Current(A)	0.0041	0.014	0.027	0.050	0.097	0.17	0.25	0.44	5.00
Measuring Voltage(V)	2.4	12.3	28.9	63.2	137.4	196.2	206.6	207.8	216.8
Measuring Current(A)	0.0122	0.041	0.081	0.149	0.291	0.52	0.76	1.32	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 27

TYPE : 5123008084(VZC-1286)

Class : C800 - - -

C.T Ratio : 2000 - 1500 - 1200 - 400 / 5A

PROJ. No. : 20120871TKE001

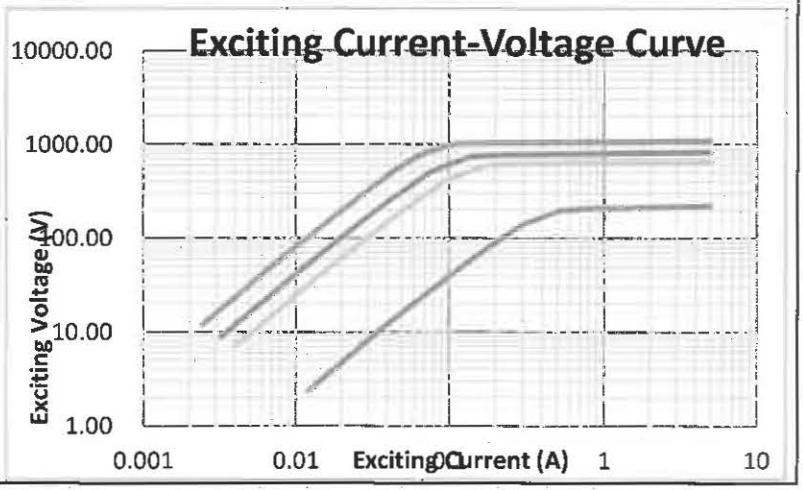
Burden : 200 VA

Frequency : 60 Hz

SERIAL NO.	CA20124301			
C.T Ratio / Test Item	2000/5A	1500/5A	1200/5A	400/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at secondary wdg 15.9 ℃	0.611	0.463	0.372	0.134
3. Secondary winding resistance at 75℃ (Rs)	0.755	0.572	0.460	0.166
4. Rated burden impedance (Zb)	8.403	6.306	5.046	1.689
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	840.29	630.55	504.55	168.89
7. Exciting current (Ie)	0.072	0.096	0.120	0.360
8. Composite error(%)	0.072	0.096	0.120	0.360
9. Current error(%) at 200 / 150 / 120 / 40 VA	-0.128	-0.177	-0.216	-0.638
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	11.8	61.3	145.9	316.2	687.2	981.2	1025.2	1039.6	1088.2
Measuring Current(A)	0.0024	0.008	0.016	0.030	0.058	0.10	0.15	0.26	5.00
Measuring Voltage(V)	8.8	46.0	109.5	237.1	515.4	735.9	768.9	779.7	816.1
Measuring Current(A)	0.0032	0.011	0.021	0.040	0.078	0.14	0.20	0.35	5.00
Measuring Voltage(V)	7.1	36.8	87.6	189.7	412.3	588.7	615.1	623.8	652.9
Measuring Current(A)	0.0041	0.014	0.027	0.050	0.097	0.17	0.25	0.44	5.00
Measuring Voltage(V)	2.4	12.3	29.2	63.2	137.4	196.2	205.0	207.9	217.6
Measuring Current(A)	0.0122	0.041	0.081	0.149	0.291	0.52	0.76	1.32	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

NO. 1212CA20124302

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE	; 5123008085(VZC-1287)	Project No.	; 20120871TKE001
Accuracy Class	; 0.3B-1.8	Pri.current	; 2000-1500-1200-400 A
Burden	; 45 VA	Sec.current	; 5 A
Serial No.	; CA20124302	Frequency	; 60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Current / Burden		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	45 VA	±0.3	±0.6	±15.6	±31.2	1±0.003	1±0.006	1±0.003	1±0.006	
2000/5 A	45 VA	-0.144	-0.188	2.51	4.51	1.00144	1.00188	1.00048	1.00015	0.367 Ω
1500/5 A	45 VA	-0.226	-0.295	3.97	7.10	1.00227	1.00296	1.00074	1.00023	0.282 Ω
1200/5 A	45 VA	-0.312	-0.412	5.69	10.10	1.00313	1.00414	1.00094	1.00025	0.228 Ω
400/5 A	45 VA	-2.016	-2.016	29.01	61.25	1.02057	1.02057	1.00942	0.99702	0.087 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : IEEE C57. 13,

Temperature 15.9 ℃ Humidity 24 %

Date 2012, 12 . 27

Tested by : J. H. KIM Reviewed by : J. Y. SIM

NO. 1212CA20124303

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE	; 5123008085(VZC-1287)	Project No.	; 20120871TKE001
Accuracy Class	; 0.3B-1.8	Pri.current	; 2000-1500-1200-400 A
Burden	; 45 VA	Sec.current	; 5 A
Serial No.	; CA20124303	Frequency	; 60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Current / Burden		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	45 VA	±0.3	±0.6	±15.6	±31.2	1±0.003	1±0.006	1±0.003	1±0.006	
2000/5 A	45 VA	-0.106	-0.151	2.44	4.46	1.00106	1.00151	1.00012	0.99980	0.364 Ω
1500/5 A	45 VA	-0.176	-0.247	3.89	7.02	1.00176	1.00248	1.00027	0.99978	0.279 Ω
1200/5 A	45 VA	-0.272	-0.373	5.55	10.04	1.00273	1.00374	1.00059	0.99988	0.225 Ω
400/5 A	45 VA	-1.963	-2.666	27.48	62.29	1.02002	1.02739	1.00945	1.00343	0.086 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : IEEE C57. 13,

Temperature 15.9 ℃ Humidity 24 %

Date 2012, 12 . 27

Tested by : J. H. KIM Reviewed by : J. Y. SIM

NO. 1212CA20124304

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE	;	5123008085(VZC-1287)	Project No.	;	20120871TKE001
Accuracy Class	;	0.3B-1.8	Pri.current	;	2000-1500-1200-400 A
Burden	;	45 VA	Sec.current	;	5 A
Serial No.	;	CA20124304	Frequency	;	60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Burden \ Current		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	45 VA	±0.3	±0.6	±15.6	±31.2	1±0.003	1±0.006	1±0.003	1±0.006	
2000/5 A	45 VA	-0.127	-0.172	2.42	4.44	1.00127	1.00172	1.00034	1.00002	0.365 Ω
1500/5 A	45 VA	-0.223	-0.294	3.85	6.97	1.00223	1.00295	1.00075	1.00027	0.280 Ω
1200/5 A	45 VA	-0.297	-0.399	5.52	10.02	1.00298	1.00401	1.00086	1.00015	0.225 Ω
400/5 A	45 VA	-1.981	-2.687	27.22	61.74	1.02021	1.02761	1.00974	1.00387	0.086 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : IEEE C57. 13,

Temperature 15.9 ℃ Humidity 24 %

Date 2012, 12 . 27

Tested by : J. H. KIM Reviewed by : J. Y. SIM

NO. 1212CA20124305~4307

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Test Certificate

Specification of Bushing Current Transformer

TYPE	; 5123008086(VZC-1288)	Project No.	; 20120871TKE001
Accuracy Class	; 1.2B-0.5	Pri.current	; 7000 A
Burden	; 12.5 VA	Sec.current	; 5 A
Serial No.	; CA20124305~4307	Frequency	; 60Hz

1. Verification of terminal marking. GOOD
2. Polarity. (Subtractive) GOOD
3. Power-frequency tests on secondary winding GOOD
   2.5 kV 60 Hz 60 sec
4. Induced voltage tests on secondary winding GOOD
   ≤ 0.2 kV 18sec at 400 Hz
5. Determination of errors. GOOD

※Rated burden, frequency and power-factor of 0.9 lagging current.

Burden \ Current		± %current error at rated current. (Percentage)		± Phase displacement at rated current. (minute)		Ratio Correction Factor		Transformer Correction Factor		Registance (at 75℃)
		100%	10%	100%	10%	100%	10%	100%	10%	
	12.5 VA	±1.2	±2.4	±62.4	±124.8	1±0.012	1±0.024	1±0.012	1±0.024	
CA20124305	12.5 VA	-0.034	-0.052	0.58	1.24	1.00034	1.00052	1.00012	1.00004	0.514 Ω
CA20124306	12.5 VA	-0.034	-0.051	0.58	1.24	1.00034	1.00051	1.00012	1.00003	0.515 Ω
CA20124307	12.5 VA	-0.048	-0.091	0.64	2.21	1.00048	1.00091	1.00023	1.00006	0.512 Ω
Result		GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	GOOD	

Applied Standard : **IEEE C57. 13,**

Temperature 15.9 ℃ Humidity 24 %

Date 2012, 12 . 27

Tested by : J. H. KIM Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD Current Transformer Certificate

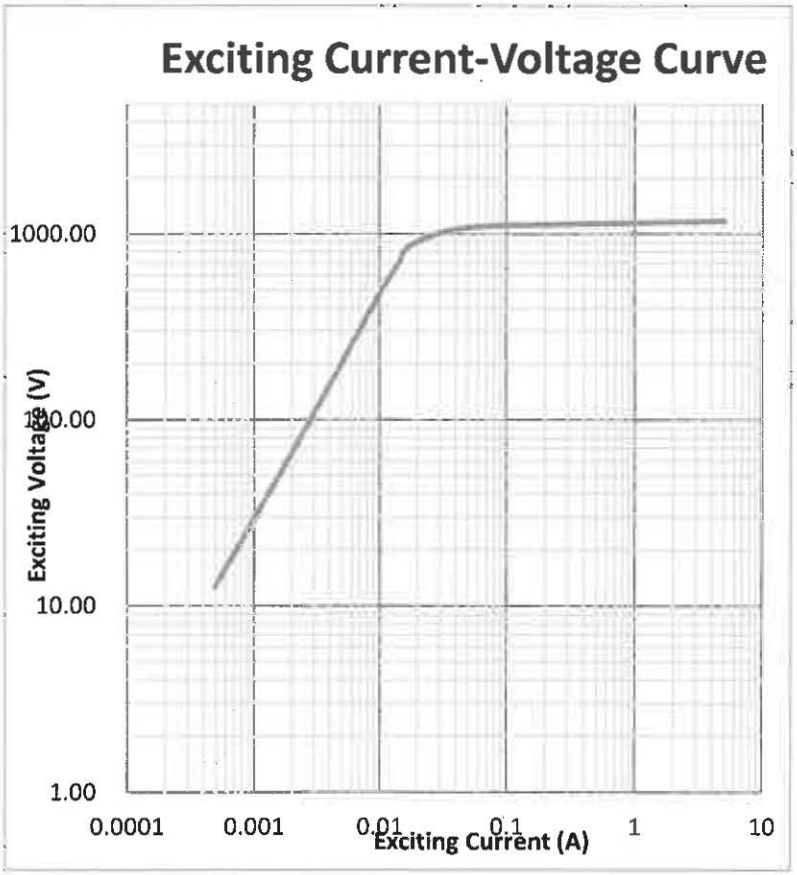
TEST STANDARD : IEEE C 57.13 | Date of Test : 2012. 12. 28

TYPE	: 5123008087(VZC-1289)	PROJ. No.	: 20120871TKE001
Class	: C800	Burden	: 200 VA
C.T Ratio	: 7000/5A	Frequency	: 60 Hz

SERIAL NO.	CA20124308
C.T Ratio / Test Item	7000/5A
	X1-X2
1. Visual check	GOOD
2. Secondary winding resistance (Rs) at 16.2 ℃	1.289
3. Secondary winding resistance at 75℃ (Rs)	1.591
4. Rated burden impedance (Zb)	8.903
5. Rated accuracy Limit current (IASA)	100
6. Exciting voltage (Es)	890.28
7. Exciting current (Ie)	0.0782
8. Composite error(%)	0.0782
9. Current error(%) at 200 VA	-0.026
10. Phase displacement(min) at 200 VA	-0.18
11. Polarity test	Subtractive
12 Induced voltage test (1.6KV, 400Hz, 18sec)	Withstood
13. Power frequency withstand test (2.5kV/ 1min.)	Withstood
14. Terminal marking (H1,H2/X1,X2)	Satisfactory

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	12.6	91.1	269.2	479.2	693.0	873.4	1074.7	1127.5	1169.8
Measuring Current(A)	0.0005	0.0026	0.0063	0.0101	0.0142	0.0181	0.0462	0.2978	5.0000



4. Rated burden impedance : VA / IS²
6. Exciting voltage (Es) : IASA × (Rs + Zb)V
8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM | Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD Current Transformer Certificate

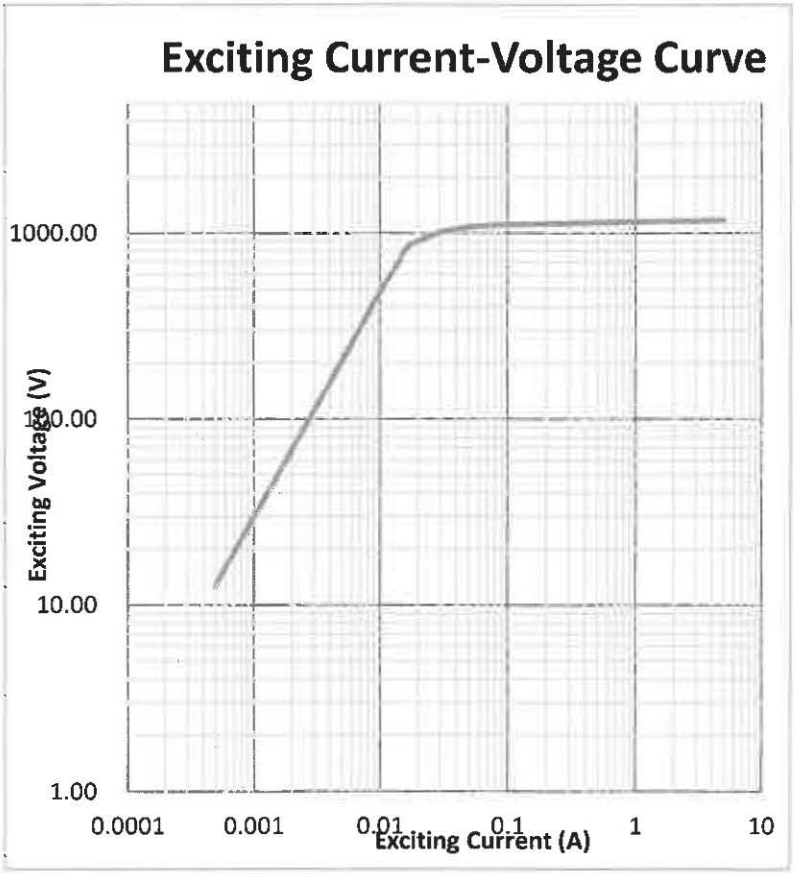
TEST STANDARD : IEEE C 57.13 | Date of Test : 2012. 12. 28

TYPE	: 5123008087(VZC-1289)	PROJ. No.	: 20120871TKE001
Class	: C800	Burden	: 200 VA
C.T Ratio	: 7000/5A	Frequency	: 60 Hz

SERIAL NO.	CA20124309
C.T Ratio / Test Item	7000/5A
	X1-X2
1. Visual check	GOOD
2. Secondary winding resistance (Rs) at 16.2 ℃	1.291
3. Secondary winding resistance at 75℃ (Rs)	1.594
4. Rated burden impedance (Zb)	8.904
5. Rated accuracy Limit current (IASA)	100
6. Exciting voltage (Es)	890.44
7. Exciting current (Ie)	0.0775
8. Composite error(%)	0.0775
9. Current error(%) at 200 VA	-0.033
10. Phase displacement(min) at 200 VA	-0.17
11. Polarity test	Subtractive
12 Induced voltage test (1.6KV, 400Hz, 18sec)	Withstood
13. Power frequency withstand test (2.5kV/ 1min.)	Withstood
14. Terminal marking (H1,H2/X1,X2)	Satisfactory

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	12.6	93.3	272.2	487.2	695.2	874.2	1069.2	1128.2	1170.5
Measuring Current(A)	0.0005	0.0026	0.0063	0.0101	0.0142	0.0181	0.0462	0.2978	5.0000



4. Rated burden impedance : VA / IS²
6. Exciting voltage (Es) : IASA × (Rs + Zb)V
8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM | Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD Current Transformer Certificate

TEST STANDARD : IEEE C 57.13

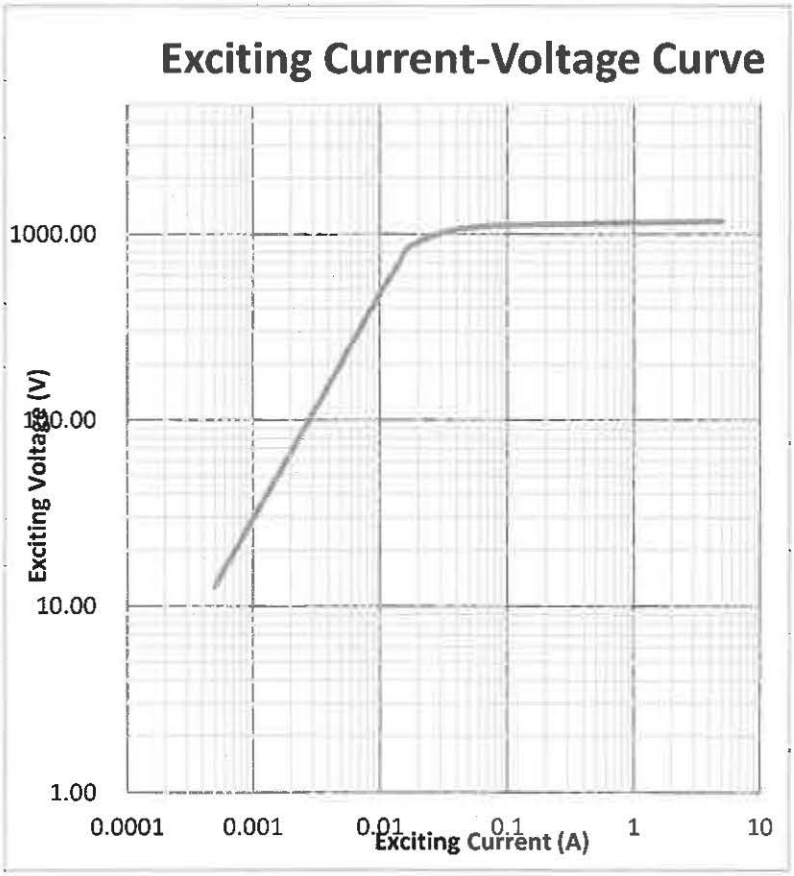
Date of Test : 2012. 12. 28

TYPE	: 5123008087(VZC-1289)	PROJ. No.	: 20120871TKE001
Class	: C800	Burden	: 200 VA
C.T Ratio	: 7000/5A	Frequency	: 60 Hz

SERIAL NO.	CA20124310
C.T Ratio / Test Item	7000/5A
	X1-X2
1. Visual check	GOOD
2. Secondary winding resistance (Rs) at 16.2 ℃	1.301
3. Secondary winding resistance at 75℃ (Rs)	1.606
4. Rated burden impedance (Zb)	8.912
5. Rated accuracy Limit current (IASA)	100
6. Exciting voltage (Es)	891.21
7. Exciting current (Ie)	0.0766
8. Composite error(%)	0.0766
9. Current error(%) at 200 VA	-0.030
10. Phase displacement(min) at 200 VA	-0.17
11. Polarity test	Subtractive
12 Induced voltage test (1.6KV, 400Hz, 18sec)	Withstood
13. Power frequency withstand test (2.5kV/ 1min.)	Withstood
14. Terminal marking (H1,H2/X1,X2)	Satisfactory

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	12.6	91.3	268.7	480.2	693.9	874.2	1075.2	1132.2	1171.2
Measuring Current(A)	0.0005	0.0026	0.0063	0.0101	0.0142	0.0181	0.0462	0.2978	5.0000



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.,LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 28

TYPE : 5123008088(VZC-1290)

PROJ. No. : 20120871TKE001

Class : C800 - - -

Burden : 200 VA

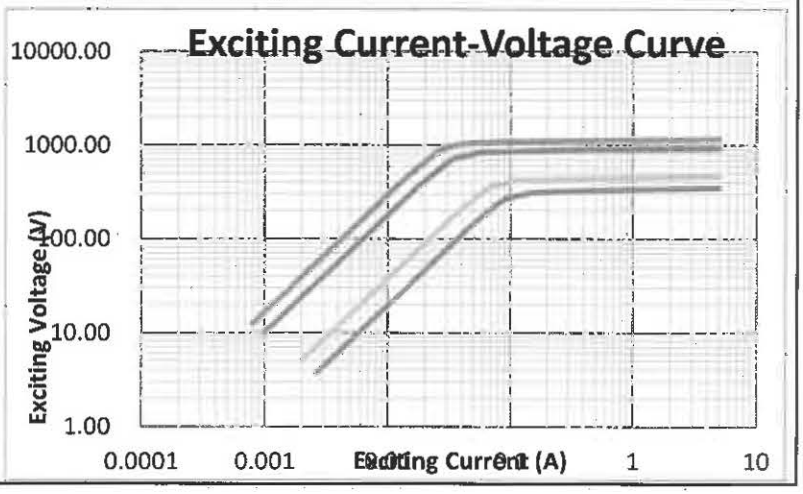
C.T Ratio : 5000 - 4000 - 2000 - 1500 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124311			
C.T Ratio / Test Item	5000/5A	4000/5A	2000/5A	1500/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at secondary wdg 16.2 ℃	1.027	0.813	0.401	0.307
3. Secondary winding resistance at 75℃ (Rs)	1.268	1.004	0.495	0.379
4. Rated burden impedance (Zb)	8.703	6.956	3.474	2.610
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	870.33	695.62	347.40	261.02
7. Exciting current (Ie)	0.074	0.093	0.185	0.247
8. Composite error(%)	0.074	0.093	0.185	0.247
9. Current error(%) at 200 / 160 / 80 / 60 VA	-0.058	-0.068	-0.217	-0.368
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	12.3	84.1	248.6	444.2	765.9	892.8	1037.6	1102.4	1155.1
Measuring Current(A)	0.0008	0.004	0.009	0.014	0.023	0.03	0.05	0.21	5.00
Measuring Voltage(V)	9.8	67.3	198.9	355.3	612.7	714.2	830.0	881.9	924.1
Measuring Current(A)	0.0010	0.005	0.011	0.018	0.029	0.03	0.06	0.26	5.00
Measuring Voltage(V)	4.9	33.6	99.4	177.7	306.4	357.1	415.0	441.0	462.0
Measuring Current(A)	0.0020	0.009	0.022	0.035	0.058	0.07	0.11	0.53	5.00
Measuring Voltage(V)	3.7	25.2	74.6	133.3	229.8	267.8	311.3	330.7	346.5
Measuring Current(A)	0.0027	0.012	0.029	0.047	0.077	0.09	0.15	0.71	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 28

TYPE : 5123008088(VZC-1290)

PROJ. No. : 20120871TKE001

Class : C800 - - -

Burden : 200 VA

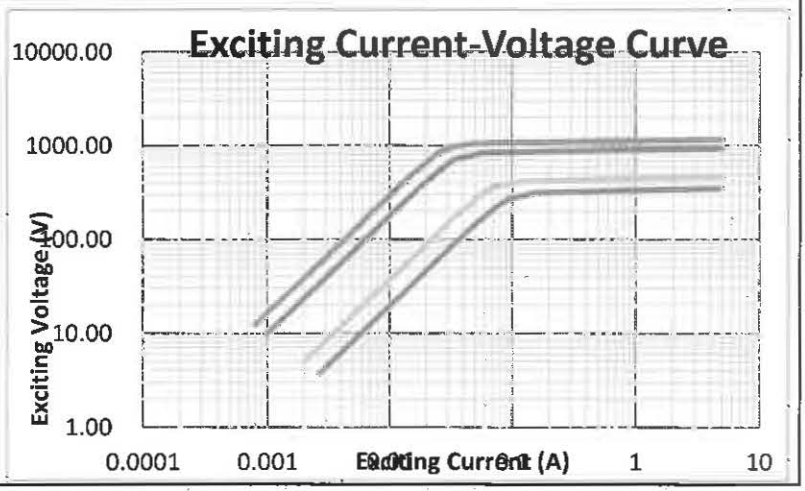
C.T Ratio : 5000 - 4000 - 2000 - 1500 / 5A

Frequency : 60 Hz

SERIAL NO.	CA20124312			
C.T Ratio / Test Item	5000/5A	4000/5A	2000/5A	1500/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 16.2 ℃	1.036	0.822	0.405	0.308
3. Secondary winding resistance at 75℃ (Rs)	1.279	1.015	0.500	0.380
4. Rated burden impedance (Zb)	8.710	6.963	3.477	2.611
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	871.00	696.30	347.70	261.09
7. Exciting current (Ie)	0.072	0.090	0.180	0.240
8. Composite error(%)	0.072	0.090	0.180	0.240
9. Current error(%) at 200 / 160 / 80 / 60 VA	-0.057	-0.065	-0.265	-0.406
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	12.3	83.2	247.7	442.2	766.2	889.7	1035.4	1098.2	1157.2
Measuring Current(A)	0.0008	0.004	0.009	0.014	0.023	0.03	0.05	0.21	5.00
Measuring Voltage(V)	9.8	66.6	198.1	353.8	612.9	711.8	828.3	878.5	925.7
Measuring Current(A)	0.0010	0.005	0.011	0.018	0.029	0.03	0.06	0.26	5.00
Measuring Voltage(V)	4.9	33.3	99.1	176.9	306.5	355.9	414.2	439.3	462.9
Measuring Current(A)	0.0020	0.009	0.022	0.035	0.058	0.07	0.11	0.53	5.00
Measuring Voltage(V)	3.7	25.0	74.3	132.7	229.8	266.9	310.6	329.5	347.2
Measuring Current(A)	0.0027	0.012	0.029	0.047	0.077	0.09	0.15	0.71	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI HEAVY INDUSTRIES CO.LTD

Current Transformer Certificate

TEST STANDARD : IEEE C57.13

Date of Test : 2012. 12. 28

TYPE : 5123008088(VZC-1290)

Class : C800 - - -

C.T Ratio : 5000 - 4000 - 2000 - 1500 / 5A

PROJ. No. : 20120871TKE001

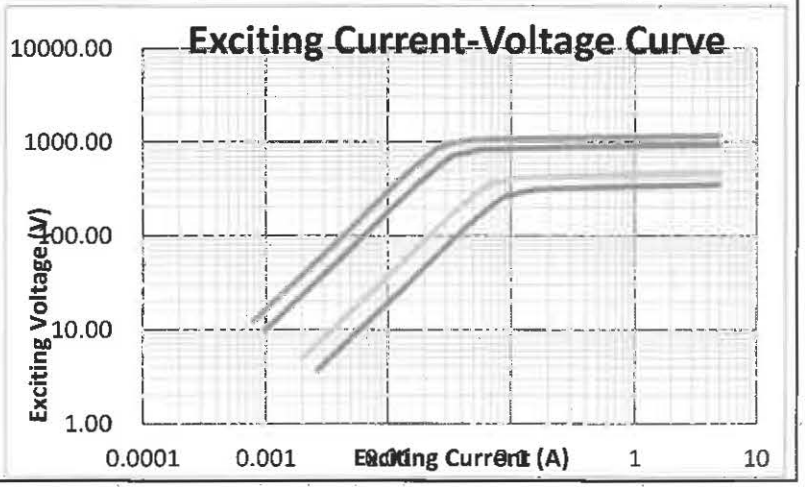
Burden : 200 VA

Frequency : 60 Hz

SERIAL NO.	CA20124313			
C.T Ratio / Test Item	5000/5A	4000/5A	2000/5A	1500/5A
	X1-X5	X1-X4	X1-X3	X1-X2
1. Visual check	GOOD			
2. Rct at . secondary wdg 16.2 °C	1.031	0.817	0.403	0.309
3. Secondary winding resistance at 75°C (Rs)	1.273	1.009	0.498	0.381
4. Rated burden impedance (Zb)	8.706	6.959	3.476	2.612
5. Rated accuracy Limit current (IASA)	100	100	100	100
6. Exciting voltage (Es)	870.63	695.92	347.55	261.17
7. Exciting current (Ie)	0.076	0.095	0.190	0.253
8. Composite error(%)	0.076	0.095	0.190	0.253
9. Current error(%) at 200 / 160 / 80 / 60 VA	-0.063	-0.085	-0.271	-0.408
10. Polarity test	Subtractive			
11. Inter-turn Overvoltage test (≤1.6kV, 400Hz/ 18sec.)	Withstood			
12. Power frequency with-stand test (2.5kV/ 1min.)	Withstood			
13. Terminal marking (H1,H2/X1,X2,X3,X4,X5)	Satisfactory			

EXCITING CURRENT CHARACTERISTIC TEST

Measuring Voltage(V)	12.3	82.1	248.7	441.4	765.2	887.2	1033.4	1102.2	1156.2
Measuring Current(A)	0.0008	0.004	0.009	0.014	0.023	0.03	0.05	0.21	5.00
Measuring Voltage(V)	9.8	65.7	198.9	353.1	612.2	709.7	826.7	881.7	924.9
Measuring Current(A)	0.0010	0.005	0.011	0.018	0.029	0.03	0.06	0.26	5.00
Measuring Voltage(V)	4.9	32.8	99.5	176.5	306.1	354.9	413.4	440.9	462.5
Measuring Current(A)	0.0020	0.009	0.022	0.035	0.058	0.07	0.11	0.53	5.00
Measuring Voltage(V)	3.7	24.6	74.6	132.4	229.6	266.2	310.0	330.7	346.9
Measuring Current(A)	0.0027	0.012	0.029	0.047	0.077	0.09	0.15	0.71	5.00



4. Rated burden impedance : VA / IS²

6. Exciting voltage (Es) : IASA × (Rs + Zb)V

8. Composite Error (%) : Ie / IASA × 100%

Tested by : J. H. KIM

Reviewed by : J. Y. SIM

HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

Customer : AUSTIN ENERGY
Project Name : ANSTIN ENERGY / DUNLAP SUBSTATION
Project. Ser. No. : 20120871-TKE001
Equipment Name : LOCAL CONTROL PANEL FOR 403/535/672MVA TRANSFORMER

INSPECTION & TEST REPORT

WITNESSED BY ;

	TESTED BY	CHECKED BY	APPROVED BY
NAME	S. Y. AHN	H. G. JI	H. Y. KIM
SIGNATURE			

We build a better future
HYUNDAI ELECTRO ELECTRIC SYSTE
HEAVY INDUSTRIES CO.,LTD.
www.hyundai-elec.com

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INSPECTION & ROUTINE TEST REPORT

Shop test date : 31-Jan-13	Project Name : ANSTIN ENERGY / DUNLAP SUBSTATION

◆ **SCOPE** ◆ **Inspection category :** ■ Self Test Checked * WITNESS TEST

■	Local Control Panel	: 1 Panel	☐	V MCC	:	Panels
☐	Remote Control Panel	: Panels	☐	V MCC	:	Panels
☐	Metrosil Panel	: Panels	☐	Metering PNL	:	Panels

◆ **CODE AND STANDARD**

■ IEEE ☐ CSA ☐ NEMA ☐ JEM ☐ KS ☐ JIS/JEC

◆ **ELECTRICAL CHARACTERISTICS**

⊙ System	: AC 1PH 3W	⊙ Type : ☐ In-door ■ Out-door
⊙ Norminal frequency	: 60 Hz	
⊙ Control power supply	: ■ DC 125 V	■ AC 120 V
⊙ Auxiliary power supply	: ☐ DC - V	☐ AC - V
⊙ Rated short time withstand current	: Sym. - KA	- Sec

◆ **GENERAL**

⊙ STEEL THICKNESS : SPHC

C	Frame	C	Front door	C	2nd door

A 1.6t B 2.0t C 2.3t D 2.6t E 3.0t F 3.2t

⊙ Painting :

Color : ANSI 70

Spec. value : above 100 ㎛

Actual value : Min.: 106 ㎛ Max.: 114 ㎛ Aver.: 110 ㎛

⊙ Degree of protection : IP → NEMA 4

⊙ Phase identification letter : 3

NO	1st	2nd	3rd	4th
1	U	V	W	N
2	A	B	C	N
3	L1	L2	N	-
4	X	Y	Z	-

Color Code					
A	Red	B	White	C	Blue
D	Black	E	Green	F	Yellow
G	Green + Yellow			H	Gray

⊙ Main bus marking color

Phase	-	Color
L1	-	F
L2	-	F
N	-	F
-	-	-

⊙ Control cable color :

AC: A,D DC: H CT: D PT: A,D Grounding: G

HYUNDAI
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1.ROUTINE TEST FOR LOCAL CONTROL PANEL ----- (1PANEL)

1) VISUAL INSPECTION ---------- (Satisfactory / *)

1) Panel arrangement and assembly condition.
2) Measurement of out-line dimension by using a scale **(See Attached Sheet 4 of 5)**

⊙ Spec. value : Width 1600 (mm) Height 1700 (mm) Depth 700 (mm)
⊙ Measur.value: Width 1601 (mm) Height 1701 (mm) Depth 701 (mm)

※ Allowance : 0～2000mm:±3mm , 2001～3000mm:±5mm , 3001～4000mm:±6mm , 4001～5000mm:±7mm
5001 ~ 6000mm:±8mm , 6001 ~ 7000mm:±9mm , 7001 ~ 8000mm:±10mm , 8001 ~ 10000mm:±15mm 10001-above:±20mm

3) Name plate and rating of panel and apparatus.
4) Wiring and connection terminal treatment.
5) Fitting apparatus and material condition.

2) MECHANICAL OPERATION TEST ---------- (N/A / *)

1) Check the mechanism like draw-out, draw-in of unit. ---------- _____

2) Check the interchange ability of draw-out type unit. ---------- _____

A VCB	B GCB	C VC/VCS	D ACB	E GPT	F PT	G BUCKET

3) MEASUREMENT OF INSULATION RESISTANCE TEST ---------- (Satisfactory / *)

■ 500V(Aux. circuit) □ 500V(Main circuit) Megger Ambient Temp. : 22℃

Main circuit	Before	L1 - E : - MΩ	L2 - E : - MΩ	L3 - E : - MΩ
		L1 - L2 : - MΩ	L2 - L3 : - MΩ	L3 - L1 : - MΩ
	After	L1 - E : - MΩ	L2 - E : - MΩ	L3 - E : - MΩ
		L1 - L2 : - MΩ	L2 - L3 : - MΩ	L3 - L1 : - MΩ
Auxiliary circuit	Before	DC : 700 MΩ	AC : 800 MΩ	MΩ
	After	DC : 700 MΩ	AC : 800 MΩ	MΩ

4) POWER FREQUENCY WITHSTAND VOLTAGE TEST ---------- (Satisfactory / *)

AC 50Hz 1 Min

Main circuit	Phase to ground	Applied voltage :	- (V)
	Phase to phase	Applied voltage :	- (V)
Auxiliary circuit	AC-Phase to ground	Applied voltage :	1500 (V)
	DC-Phase to ground	Applied voltage :	1500 (V)

5) ELECTRICAL OPERATION TEST AND VERITICATION WIRING ----- (Satisfactory / *)

■ Circuit breaker operation test
□ Inter-lock check
■ Lighting and heater test
□ Three line check (relay)
■ Control circuit check
■ Aux. contact check
□ Phase check
□ Polarity check

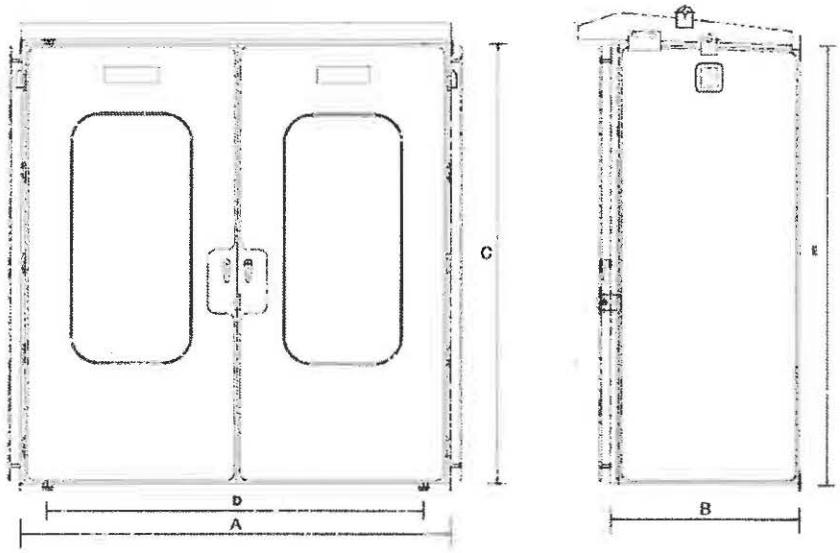
HYUNDAI
HEAVY INDUSTRIES CO.,LTD.

Sheet No. : 4 of 5

CHECK SHEET OF DIMENSION

PROJ./SER.NO.	20120871-TKE001	CUSTOMER	AUSTIN ENERGY
PROJECT ITEM	LOCAL CONTROL PANEL		
PANEL DWG NO.	TL-2363	INSPECTOR	S .Y .AHN
QUANTITY	1 PANEL	INSPECTION DATE	16-Jan-13

SKETCH :



UNIT : mm

CHECK POINT	A	B	C	D	E	F	G	H
SPEC. VALUE	1600	700	1700	1400	1730	-	-	-
ALLOWANCE	±3	±3	±3	±3	±3	-	-	-
MEASU. VALUE	1601	701	1701	1401	1731	-	-	-
CHECK POINT	I	J	K	L	M	N	O	P
SPEC. VALUE	-	-	-	-	-	-	-	-
ALLOWANCE	-	-	-	-	-	-	-	-
MEASU. VALUE	-	-	-	-	-	-	-	-

RESULT : **GOOD**

HHI A24-440-0

A4 (210m

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TEST EQUIPMENT

Sheet No. : 5 of 5

NO.	TEST EQUIPMENT	SPEC.	USE	Calibration date (1Year after calibration)
1	Digital Tester	AC/DC 0-1000 V, A, OHM	■	97820830 (2012.03.14)
2	3PH Power Supply Equipment	3PH 440/220 V,DC110/24V, AC 0-12A	■	10-6432-001 (2012.03.14)
3	Megger Tester	500 V 1000 MΩ	■	090903711 (2012.03.14)
4	Megger Tester	1000 V 2000 MΩ	□	
5	High Voltage T/R	25000 / 220V	□	
6	Puncture Tester	0-5 kV 500 VA	■	HS023 (2012.03.14)
7	Puncture Tester	0-3 kV 600 mA	□	
8	Vernier Calipers	0-200mm	■	379229 (2012.03.14)
9	Clamp On Hitester	0 ~ 600V/1000A	■	070910094 (2012.03.14)
10	Handy Calibrator	DC 1~30V/100mV/4~20mA	■	T1H7017 (2012.03.14)
11	Thickness Gauge	0-1000㎛	■	AK0135 / BB0362 (2012.03.14)
12	Relay Tester	0-300V, 0-50A	□	
13	DC-A Supply	DC 0-600A, 10V	□	
14	Steel Tape	0~20m	■	
15	V-A Meter (DC)	0-1000V / 30A	□	
16	V-A Meter (AC)	0-750V / 30A	□	
17	Spring Balance	0~500g 1φ	□	
18	Photo Recorder	10/200 Cm/MIN/SEC	□	
19	Digital Oscilloscope	8 Bit 200ms/s 150Hz	□	
20	Temp. Recorder	0 - 300 ℃	□	
21	Decade R-Box	1.1 kΩ / 100 kΩ	□	
22	High Current Gen.	3PH, 0-6000A	□	
24	Motor Gen. Set	25KVA, 440/380V, 50/60HZ	□	
25	High Current Supply	0-2000A, 0-300V	□	

HYUNDAI HEAVY INDUSTRIES CO., LTD.

COATING INSPECTION REPORT
(도장 검사 보고서)

		REPORT NO. (보고서번호)	KS-13.1-21
		DATE OF ISSUE (발행일자)	2013.01.22
PROJECT NAME (공사명)	AUSTIN ENERGY / DUNLAP SUBSTATION	ITEM (품 명)	LOCAL CONTRÓL PANEL
PROJECT NO. (공사번호)	20120871-TKE001	CUSTOMER (고 객)	AUSTIN ENERGY
DWG NO. (도면번호)	TL-2363 / Rev.0	DOCUMENT NO. (절차서번호)	DMP-JAYU-001
ITEM NO. (부품번호)		Q'TY (수 량)	1 SETS

SURFACE PREPARATION (표면처리)

DATE/TIME (작업일자/시간)	2013.01.17 10:30	APPLICABLE CODE (적용규격)	SSPC-SP8
PHOSPHATING FILM (인산염피막)	1~3 ㎛	PHOSPHATING FILM THICKNESS (인산염 피막두께)	2.66㎛
SURFACE CONDITION(표면상태)	오일,습기,오염물질,발청부제거,용접스패터,가공면MASKING		GOOD

WEATHER CONDITION DATE & D.F.T. FOR PAINTING
기상상태 날짜 및 도장 두께

DATE (날짜)	2013.01.17	건/습구온도	4℃/1℃	R.H(%) (상대습도80%이하)	58%	STEEL TEMP. (표면온도)	0℃	DEWPOINT (이슬점온도)	-4℃

SPECIFICATION & USED COATING (사 양 & 사용도료)	1'st Coating	INT	EX8700-ZR/35㎛	COATING (도장상태) IN: WHITE OUT: ANSI 70	1'st Coating	INT	39.1㎛
		EXT	EX8700-ZR/40㎛			EXT	43.9㎛
	2'nd Coating	INT	N/A		2'nd Coating	INT	N/A
		EXT	PX4324/30㎛			EXT	76.1㎛
	Finish Caoting	INT	PX4324/35㎛		Finish Coating	INT	76.2㎛
		EXT	UT6780/30㎛			EXT	110.4㎛

MAKER (도료제작사)	KCC	SPEC:100㎛ above	MIN. 106㎛	MAX. 114㎛	AVER. (평 균)	110.4㎛

COATING THICKNESS GAUGE(도막측정기)	LOT NO.	검교정일자	검교정 NO.	MAKER
	KC20509128	2012.05.19	OM 179-745	OMEGA/1~1500㎛/102086

COMMENTS (문제점 및 특기사항): *.표면온도가 이슬점 온도보다 3℃ 이상

SURFACE PROFILE REPLICA TAPE : N/A

RESULT: ■ ACCEPTED ☐ REJECTED

	Inspected By	Checked By	Approved By
PRO'N DEPT	2013.01.22	2013.01.22	2013.01.22

345Z2000AD *1000040107*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	1/30/2012		
Apparatus:	Condenser Bushing	**ABB Job Number:**	9011606
Bushing Type:	O Plus C II	**ABB Order Number:**	XAM13182
Style:	345Z2000AD	**Version:** 1	
Rating:	345 **kV**		
BIL:	1175**kV**	2000 **Amps (Bottom Connected)**	
Max L-G Voltage:	220**kV**		
Serial Number:	1000040107		
Ambient Temperature:	22 **°C**	**Humidity:** 23%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #559
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.33	571
(C2) Tap to Flange	10	.33	8015
Stud to Flange	10	N/A	N/A

2. **Impulse:** All units rated 362kV & 1050kV BIL and above, received 5 full wave impulses, nominal 1.2 x 50 microseconds, prior to the 60 Hz withstand test.
3. **Tap Test:** 20 kV 60 Hz one minute applied test, tap to flange: Passed
4. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
330	NA	2	NA
560	1	6	4
330	15	2	2
NA	NA	NA	NA
NA	NA	NA	NA

5. **After 60 Hz Withstand (Nameplate Information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.33	572
(C2) Tap to Flange	10	.32	8018
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable IEC standards.

Test Specialist: Michael Vernon **Date:** 1/30/2012 6:52:14 PM

Remarks:
.33 *572* *.32* *8018*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

345Z2000AD *1000040108*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	1/28/2012		
Apparatus:	Condenser Bushing	**ABB Job Number:**	9011606
Bushing Type:	O Plus C II	**ABB Order Number:**	XAM13182
Style:	345Z2000AD	**Version:** 1	
Rating:	345 **kV**		
BIL:	1175**kV**	2000 **Amps (Bottom Connected)**	
Max L-G Voltage:	220**kV**		
Serial Number:	1000040108		
Ambient Temperature:	19 **°C**	**Humidity:** 34%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #559
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.34	570
(C2) Tap to Flange	10	.34	7929
Stud to Flange	10	N/A	N/A

2. **Impulse:** All units rated 362kV & 1050kV BIL and above, received 5 full wave impulses, nominal 1.2 x 50 microseconds, prior to the 60 Hz withstand test.
3. **Tap Test:** 20 kV 60 Hz one minute applied test, tap to flange: Passed
4. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
330	NA	2	NA
560	1	13	10
330	15	2	2
NA	NA	NA	NA
NA	NA	NA	NA

5. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.32	571
(C2) Tap to Flange	10	.34	7934
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Michael Vernon **Date:** 1/28/2012 12:36:42 PM

Remarks:
.32 *571* *.34* *7934*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

345Z2000AD *1000040109*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	1/30/2012		
Apparatus:	Condenser Bushing	**ABB Job Number:**	9011606
Bushing Type:	O Plus C II	**ABB Order Number:**	XAM13182
Style:	345Z2000AD	**Version:** 1	
Rating:	345 **kV**		
BIL:	1175**kV**	2000 **Amps (Bottom Connected)**	
Max L-G Voltage:	220**kV**		
Serial Number:	1000040109		
Ambient Temperature:	22 **°C**	**Humidity:** 23%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #559
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.34	581
(C2) Tap to Flange	10	.33	8054
Stud to Flange	10	N/A	N/A

2. **Impulse:** All units rated 362kV & 1050kV BIL and above, received 5 full wave impulses, nominal 1.2 x 50 microseconds, prior to the 60 Hz withstand test.
3. **Tap Test:** 20 kV 60 Hz one minute applied test, tap to flange: Passed
4. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
330	NA	2	NA
560	1	10	5
330	15	2	2
NA	NA	NA	NA
NA	NA	NA	NA

5. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.33	582
(C2) Tap to Flange	10	.32	8058
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Michael Vernon **Date:** 1/30/2012 4:51:08 PM

Remarks:
.33 *582* *.32* *8058*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

025W2000BE *1000039897*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	12/5/2011		
Apparatus:	Condenser Bushing	**ABB Job Number:**	9011573
Bushing Type:	O Plus C	**ABB Order Number:**	XAM13165
Style:	025W2000BE	**Version:** 7	
Rating:	25 **kV**		
BIL:	150**kV**	2000 **Amps (Bottom Connected)**	
Max L-G Voltage:	16**kV**		
Serial Number:	1000039897		
Ambient Temperature:	18 **°C**	**Humidity:** 54%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #610
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.25	550
(C2) Tap to Flange	1	NA	NA
Stud to Flange	NA	N/A	N/A

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
24	NA	1	NA
75	1	1	1
24	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.25	550
(C2) Tap to Flange	1	.13	264
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Sonny Brice **Date:** 12/5/2011 8:22:59 AM

Remarks:
.25 *550* *.13* *264*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

138W4000UU *1000060199*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	12/17/2012 12:35:07 PM		
Apparatus:	Condenser Bushing	**ABB Job Number:**	22056049
Bushing Type:	O Plus C	**ABB Order Number:**	XAM13975
Style:	138W4000UU	**Version:** 2	
Rating:	138 **kV**		
BIL:	650**kV**	4000 **Amps (Bottom Connected)**	
Max L-G Voltage:	102**kV**		
Serial Number:	1000060199		
Ambient Temperature:	18 **°C**	**Humidity:** 56%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std: C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #091
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.30	424
(C2) Tap to Flange	10	.31	4435
Stud to Flange	NA	NA	NA

2. **Tap Test:** 20 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
153	NA	1	NA
325	1	3	3
153	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate Information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.32	425
(C2) Tap to Flange	10	.30	4434
Stud to Flange	NA	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Tony Ballard **Date:** 12/17/2012 12:22:28 PM

Remarks:
.32 *425* *.30* *4434*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

138W4000UU *1000060200*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	12/18/2012 2:51:14 PM		
Apparatus:	Condenser Bushing	**ABB Job Number:**	22056049
Bushing Type:	O Plus C	**ABB Order Number:**	XAM13975
Style:	138W4000UU	**Version:** 2	
Rating:	138 **kV**		
BIL:	650**kV**	4000 **Amps (Bottom Connected)**	
Max L-G Voltage:	102**kV**		
Serial Number:	1000060200		
Ambient Temperature:	18 **°C**	**Humidity:** 38%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #091
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.32	425
(C2) Tap to Flange	10	.30	4344
Stud to Flange	NA	NA	NA

2. **Tap Test:** 20 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
153	NA	1	NA
325	1	14	10
153	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.32	425
(C2) Tap to Flange	10	.30	4344
Stud to Flange	NA	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Sonny Brice **Date:** 12/18/2012 2:50:58 PM

Remarks:
.32 *425* *.30* *4344*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

138W4000UU *1000060201*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	12/18/2012 3:14:42 PM		
Apparatus:	Condenser Bushing	**ABB Job Number:**	22056049
Bushing Type:	O Plus C	**ABB Order Number:**	XAM13975
Style:	138W4000UU	**Version:** 2	
Rating:	138 **kV**		
BIL:	650**kV**	4000 **Amps (Bottom Connected)**	
Max L-G Voltage:	102**kV**		
Serial Number:	1000060201		
Ambient Temperature:	21 **°C**	**Humidity:** 38%	

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #091
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.32	425
(C2) Tap to Flange	10	.31	4555
Stud to Flange	NA	NA	NA

2. **Tap Test:** 20 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
153	NA	1	NA
325	1	2	2
153	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.32	425
(C2) Tap to Flange	10	.31	4555
Stud to Flange	NA	NA	NA

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Tony Ballard **Date:** 12/18/2012 3:13:48 PM

Remarks:
.32 *425* *.31* *4555*

Form: CTR-Condenser Bushings/IEEE v1.0 Form Date: 1/1/2000

034T0600JR *1000032721*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	8/11/2011		
Apparatus:	Condenser Bushing	**ABB Job Number:**	1777402
Bushing Type:	T	**ABB Order Number:**	
Style:	034T0600JR	**Version:** 3	
Rating:	34.5 **kV**		
BIL:	200**kV**	6000 **Amps (Bottom Connected)**	
Max L-G Voltage:	22**kV**		
Serial Number:	1000032721		
Ambient Temperature:	25 **°C**		

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #610
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.23	757
(C2) Tap to Flange	1	NA	NA
Stud to Flange	NA	N/A	N/A

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
33	NA	1	NA
80	1	3	2
33	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.24	757
(C2) Tap to Flange	1	.30	485
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Joe Barton **Date:** 8/11/2011 6:55:46 AM

Remarks:
Oil Level: 6.375

.24 *757* *.30* *485*

Form: CTR-Condenser Bushings/Type T v1.0 Form Date: 1/1/2000

034T0600JR *1000032722*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	8/11/2011		
Apparatus:	Condenser Bushing	**ABB Job Number:**	1777402
Bushing Type:	T	**ABB Order Number:**	
Style:	034T0600JR	**Version:** 3	
Rating:	34.5 **kV**		
BIL:	200**kV**	6000 **Amps (Bottom Connected)**	
Max L-G Voltage:	22**kV**		
Serial Number:	1000032722		
Ambient Temperature:	25 **°C**		

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #610
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.24	770
(C2) Tap to Flange	1	NA	NA
Stud to Flange	NA	N/A	N/A

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
33	NA	1	NA
80	1	3	3
33	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.24	770
(C2) Tap to Flange	1	.28	489
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable IEC standards.

Test Specialist: Joe Barton **Date:** 8/11/2011 6:23:55 AM

Remarks:
Oil Level: 6 3/8"

.24 *770* *.28* *489*

Form: CTR-Condenser Bushings/Type T v1.0 Form Date: 1/1/2000

034T0600JR *1000032723*

Alamo, Tennessee
CERTIFIED TEST REPORT
Status: Passed

Test Date:	8/11/2011		
Apparatus:	Condenser Bushing	**ABB Job Number:**	1777402
Bushing Type:	T	**ABB Order Number:**	
Style:	034T0600JR	**Version:** 3	
Rating:	34.5 **kV**		
BIL:	200**kV**	6000 **Amps (Bottom Connected)**	
Max L-G Voltage:	22**kV**		
Serial Number:	1000032723		
Ambient Temperature:	25 °C		

1. **Power Factor and Capacitance**
The power factor/capacitance test is conducted per IEEE Std. C57.19.00-2004 & Std. C57.19.01-2000. An Ailtech NM-21FFT radio noise meter per NEMA 107-1987 is used for partial discharge measurements in microvolts. Test equipment includes a dielectric test set for measurements above 10kV and a dissipation factor/capacitance bridge #610
Before 60 Hz Withstand

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.24	765
(C2) Tap to Flange	1	NA	NA
Stud to Flange	NA	N/A	N/A

2. **Tap Test:** 2 kV 60 Hz one minute applied test, tap to flange: Passed
3. **Dry 60 Hz Withstand and Partial Discharge:**
The tests were conducted per IEEE Std. C57.19.00-2004, IEEE Std. C57.19.01-2000 specifications. The dielectric and partial discharge detection equipment is designed to meet or exceed IEEE 454-1973, C57.113-1991, and C63.2-1996 requirements which includes dividers, detectors, power sources to 1MV, and partial discharge detectors.

		Start	Finish
Test Voltage (kV)	**Test Duration (Min)**	**PC**	**PC**
33	NA	2	NA
80	1	3	3
33	NA	1	NA
NA	NA	NA	NA
NA	NA	NA	NA

4. **After 60 Hz Withstand (Nameplate information):**

Measurement	Applied kV	Power Factor (%)	Capacitance (Pfd)
(C1) Stud to Tap	10	.24	765
(C2) Tap to Flange	1	.26	476
Stud to Flange	NA	N/A	N/A

The pressure and vacuum sealing of this bushing has been verified by testing in accordance with IEEE C57.19.00 - 2004 section 7.4.5. This unit was filled at the factory with PCB-free (non-detectable) dielectric fluid in accordance with U.S. Federal polychlorinate biphenyl (PCB) regulation 40 CFR 61, dated May 31, 1979. The analysis is verified per ASTM-D4059 with a detection level of less than 1 ppm. Bushings are filled with mineral oil that is certified passivator free and certified tested corrosive sulfer free. All tests were conducted on bushings that meet or exceed IEEE C57.19.00-2004.
All dielectric withstand levels for power frequency meet or exceed the routine test levels required by the applicable **IEC** standards.

Test Specialist: Joe Barton **Date:** 8/11/2011 6:41:34 AM

Remarks:
Oil Level: 6.375"

.24 *765* *.26* *476*

Form: CTR-Condenser Bushings/Type T v1.0 Form Date: 1/1/2000

Routine Test Report for MR-Products

MR order no.:	**20125226**
MR serial no.:	**1246895**
Customer order. no. / Date:	**WE110TB2M231 / 08.09.2011**
Your sign:	**LEE SO YOUNG**
Transformer Manufacturer:	**HYUNDAI HEAVY INDUSTRIES CO., LTD. Electro Electric Systems**
Highest voltage for equipment [kV]	**300,0 kV**
Transition resistor: [Ohm]	
Rated step voltage: [V]	**4.980,00 V**
Rated through current: [A]	**881,00 A**

Tests to be carried out on off-circuit tap-changer DEETAP 3 X DU I 1222-300-06 05 0ME

Test	**passed**
- Functional test of sub-assemblies	✓
- Leakage test of the head by means of helium	✓
- Auxiliary circuits insulation test (2.5 kV / 1 minute)	✓
- Functional test of the complete off-circuit tap-changer	✓

The product was tested according to IEC 60214-1 and to MR's test plans.
The product has passed the tests successfully and has been released by quality assurance.
All requirements of IEEE Std C57.131 were fulfilled.

Test for the qualification of insulating materials

Test		**passed**
component description:	test performed:	
- contact bar	measurement of partial discharge	✓
- cage ring	measurement of partial discharge	✓

Routine tests were carried out on all subassemblies.

Regensburg,
26.10.2011
Maschinenfabrik Reinhausen GmbH
Quality Management
Mr. Badenberg

(Computer printout, valid without signature)

Routine Test Report for MR-Products

MR order no.:	**20125226**
MR serial no.:	**1246895**
Customer order. no. / Date:	**WE110TB2M231 / 08.09.2011**
Your sign:	**LEE SO YOUNG**
Transformer Manufacturer:	**HYUNDAI HEAVY INDUSTRIES CO., LTD.** **Electro Electric Systems**

Tests to be carried out on the hand drive TAPMOTION® DD

Test	**passed**
- Functional test of sub-assemblies	✓

Regensburg,
27.10.2011
Maschinenfabrik Reinhausen GmbH
Quality Management
Mr. Badenberg

(Computer printout, valid without signature)

RS4016:06

General Description of the Routine Test
On-Load Tap Changer Type RMV-II

Serial No: 1337933 Type: RMV-II-2500-72.5 Wiring Diagram: 3152160

Transformer Manufacturer: HYUNDAI – S. KOREA P.O. NO.: WA120TB2MR12 S.O.: 20120820-TR-0119, 20120871TKE001

1. **On Load Tap Changer**

1.1 **Mechanical Test**
The stopping on position was verified during one complete cycle of operation. Additionally a minimum of 10 complete cycles of operation in transformer oil were successfully performed.

1.2 **Sequence Test**
After the Mechanical Test under 1.1, a complete cycle of operation was recorded oscillographically. The opening and closing of all contacts was within the admissible tolerance range.

1.3 **Pressure Test of the Oil Compartment**
An Oil Pressure Test at 10 psi for 1 hour confirmed that the LTC oil compartment was pressure- tight.

2. **Vacuum Interrupter and Monitoring System**

2.1 **Hipot Test of the Vacuum Interrupters**
A Hipot Test of 25KV AC for 1 minute was performed successfully.

2.2 **Functional Check of the Monitoring System**
A Monitoring Operational Tripping Test was performed to verify the integrity of all components.

3. **Motor Drive Unit**

3.1 **Electrical/Mechanical Test**
Functional tests covering standard and optional features according to the corresponding wiring diagram were successful. A minimum of 10 complete cycles of operation were successfully performed.

All the operational tests performed with nominal driving torque at 85%, 100%, and 110% of rated supply voltage were successful.

3.2 **Voltage Test**
The 1.5 KV AC for 1 minute Voltage Test of the complete electrical wiring system to the housing was entirely satisfactory.

Elements which are to be tested with lower test voltages (for example Selsyn Transmitter) were not included in the test.

Reinhausen Manufacturing Inc.
Quality Assurance

11/12/2012

Reinhausen Manufacturing Inc.
2549 North 9th Avenue
Humboldt, TN 38343, U.S.A.

Phone +1 731 784 7681
Fax +1 731 784 7682
www.Reinhausen.com

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TELEFONO +39 02 98.20.44.11 - TELEFAX +39 02 98.20.44.22
E-Mail: cedaspe@cedaspe.com - InterNet Site: http://www.cedaspe.com
CAP. SOC € 500.000 I.V. - TVA-P.I. 01065780155 - C.F. 01065780155
R.E.A. MI 729991 - IMPORT-EXPORT MI 142410 - REG. IMPR. 132146/3344/46 TRIB. MI

T E S T C E R T I F I C A T E ACC. TO EN 10204 2-2

GAS OPERATED BUCHHOLZ RELAY EN 50216-2

Model: EE3-ML 1"BSP
Cedaspe code: ABEE30ML06 Description: RELE' EE3-ML 1"BSP(2CX*1M*FVT*A2)
Serial number: SR 0106 - Manufacturing year: 2012
Execution for mineral oil - Protection degree: IP 65
Wiring contact diagram set at delivery: ML
Performance of contacts:
A) N/O contacts (SPST)
- Rated current: 3A a.c. or d.c.
- Rated voltage 24-250V a.c.(at 50Hz) or d.c.
- Breaking capacity: 400VA a.c. or 250W d.c.

B) Changeover contacts (SPDT)
- Rated current: 1A a.c. or d.c.
- Rated voltage 24-250V a.c.(at 50Hz) or d.c.
- Breaking capacity: 200VA a.c. or 120W d.c.

TEST CARRIED OUT

1) Oil tightness test
   With transformer oil, overpressure of 100 kPa for 140 hours at room temperature.
2) Operational tests:
   a) air injecting through the gas cock: alarm
   b) by running off the test liquid: alarm and trip (oil leakage)
   c) by running the test liquid through the relay: trip (oil surge)
   d) by means of push button self-returning, at the relay full of test liquid. Pressing the button, first the alarm contact is activated and afterwards also the trip contact is activated.
3) Operational values
   Alarm: 230 cc (gas collection)
   Trip : 100 cm/sec (oil surge)
   Trip : The trip contact for oil leakage is actuated after alarm due to gas collection and before reaching the lowest point of the pipe.
4) Dielectric strength test
   a) With 2000V a.c. (50Hz) for 60" between electrical circuits and casing.
   b) With 2000V a.c. (50Hz) for 60" between indipendent circuits.
   The dielectric strength tests have been executed with relay empty of test liquid.

NOTE: CABLE ENTRY 1" BSP

CUSTOMER: 000341 HYUNDAI HEAVY INDUSTRIES CO., LTD.
ORDER N°: PO WE208TB5CE11-REV.1
ORDER CONFIRMATION N°: 042702

DATE: 29.05.2012
TESTER: G.RANDAZZO
This certificate is electronically issued and approved by Quality Manager and does not require signature

Brands:
SEN
Rotherwood
QUALITROL
QWAVE

QUALITROL®

Qualitol LLC
1385 Fairport Rd.
Fairport, NY 14534 USA
Tel: 1-585-586-1515

Liquid Level Gage and Flow Gage Test Certificate

[Flüssige waagerecht ausgerichtete Lehren-und Fluss-Lehren-Test-Bescheinigung]
{ Jauge de niveau et certificat d'essai de mesure d'écoulement}
Certificado de prueba del calibrador llano líquido y del calibrador del flujo

Model No.[Modell-Nr.] {No de modele} No. de modelo	LLG042-00048299	
Order No. [Auftrags-Nr.] {No de commande} No. de orden de ventas	50082725	Line: 5
Serial No. [Geräte-Serien-Nr.] {N° de série} No. de serie	50082725-5-1	1 of 1
Customer [Kunde] {Client} Cliente	HYUNDAI HEAVY IND. CO. LTD.	
Date Code [Datums-Code] {Code Date} Codigo de fecha	5/14/2012	
Customer Part No. [Kunde Teil-Nr.] {No Pièce De Client} No. de Pieza Del Cliente		
Customer Purchase Order No. [Auftrags-Nr.] {No de commande} No. de orden de compra	WA203TB5QT38	

PACKING CHECKLIST ACCESSORIES	
Dial	DAL000-00063835
Glass	001-60-15A
Bezel	251-60-13A
Pointer	032-60-18A
Connector	CON000-0018740:
Float Rod	0.00
	030-60-24A 8
Plate	
Flange	FLA-139-1
Support	SUP-068-394Y
Gear	042-35-48 2:1 5 in/lb
Vane	

Calibration [Kalibrieung] {Calibrage} Calibracion

✓	Switch 1 [Schalter 1] {Contact 1} Contacto 1
✓	Switch 2 [Schalter 2] {Contact 2} Contacto 2
NA	Switch 3 [Schalter 3] {Contact 3} Contacto 3

Electrical [Elektrisch] {Electrique} Electrical

✓	Switch Wiring [Schalterverdrahtung] {Cablage des Contacts} Alambrado del Contacto	6Q02
✓	High Potential Test Passed (60 second to ground) Hochspannungs-Prüfung (60 sec. gegen Erde) Test d'isolement (60 secondes à la terre) Alta prueba potencial pasajera (60 en segundo lugar a la tierra)	2000V @ 0.5mA

Mechanical [Mechanisch] {Mecanique} Mecanico

NA	Leak Test [Leckage-Prüfung] {Test d'étanchéité} Prueba de Fugas
	Smooth Pointer Travel [Leichter Lauf des Zeigers] {Deplacement de l'aiguille sans frottement} Desplazamiento de aguja sin friccion
NA	Over Travel Equal [Gleicher Uberhang] {Centrage de l'echelle} Sobredesplazamiento igual
NA	Smooth Gear Movement [Leichter Lauf des Getriebes] {mouvement du pignon sans frottement} Movimiento de engranes sin friccion
NA	Vane Travel Confirmed [Schaufel-Spielraum bestätigt] {Le voyage de palette a confirmé} Recorrido de la paleta confirmado

Completed By [Bearbeitet von] {Rempli par} Terminado cerca	Ron	Calibration by [Kalibrieung von] {Calibrage par} Calibracion	Ron	Date [Datum] {Date} Fecha	5/14/2012

Compliance Statement [Befolgung-Aussage] {Rapport de conformité} Declaración de la conformidad

To Whom It May Concern:

This is to certify that our products were manufactured, inspected, and accepted as conforming to your purchase order, and all applicable drawing and specification requirements. We further certify that the units have been tested and operate according to product performance specifications.

Director of Operations

Quality Manager

Form 0-569 English [German] {French} Spanish
Rev. F 1/17/02

QUALITROL®

Qualitol LLC
1385 Fairport Rd.
Fairport, NY 14534 USA
Tel: 1-585-586-1515

Liquid Level Gage and Flow Gage Test Certificate

[Flüssige waagerecht ausgerichtete Lehren-und Fluss-Lehren-Test-Bescheinigung]
{ Jauge de niveau et certificat d'essai de mesure d'écoulement}
Certificado de prueba del calibrador llano líquido y del calibrador del flujo

Model No.[Modell-Nr.] {No de modele} No. de modelo	LLG032-00048300
Order No. [Auftrags-Nr.] {No de commande} No. de orden de ventas	50101299 Line: 7
Serial No. [Geräte-Serien-Nr.] {N° de série} No. de serie	50101299-7-1 1 of 1
Customer [Kunde] {Client} Cliente	HYUNDAI HEAVY IND. CO. LTD.
Date Code [Datums-Code] {Code Date} Codigo de fecha	12/6/2012
Customer Part No. [Kunde Teil-Nr.] {No Pièce De Client} No. de Pieza Del Cliente	
Customer Purchase Order No. [Auftrags-Nr.] {No de commande} No. de orden de compra	WA210TB5QT93

PACKING CHECKLIST ACCESSORIES	
Dial	DAL000-00050262
Glass	001-60-15A
Bezel	251-60-13A
Pointer	032-60-18A
Connector	CON000-0018740
Float Rod	ROD000-0005082 27.97
	032-60-24A 1
Plate	
Flange	FLA-139-1
Support	032-60-35N
Gear	
Vane	

Calibration [Kalibrieung] {Calibrage} Calibracion

✓	Switch 1 [Schalter 1] {Contact 1} Contacto 1
✓	Switch 2 [Schalter 2] {Contact 2} Contacto 2
NA	Switch 3 [Schalter 3] {Contact 3} Contacto 3

Electrical [Elektrisch] {Electrique} Electrical

✓	Switch Wiring [Schalterverdrahtung] {Cablage des Contacts} Alambrado del Contacto	6Q02
✓	High Potential Test Passed (60 second to ground) Hochspannungs-Prüfung (60 sec. gegen Erde) Test d'isolement (60 secondes à la terre) Alta prueba potencial pasajera (60 en segundo lugar a la tierra)	2000 V @ 0.5mA

Mechanical [Mechanisch] {Mecanique} Mecanico

NA	Leak Test [Leckage-Prüfung] {Test d'étanchéité} Prueba de Fugas
	Smooth Pointer Travel [Leichter Lauf des Zeigers] {Deplacement de l'aiguille sans frottement} Desplazamiento de aguja sin friccion
	Over Travel Equal [Gleicher Uberhang] {Centrage de l'echelle} Sobredesplazamiento igual
NA	Smooth Gear Movement [Leichter Lauf des Getriebes] {mouvement du pignon sans frottement} Movimiento de engranes sin friccion
NA	Vane Travel Confirmed [Schaufel-Spielraum bestätigt] {Le voyage de palette a confirmé} Recorrido de la paleta confirmado

Completed By [Bearbeitet von] {Rempli par} Terminado cerca: Ron
Calibration by [Kalibrieung von] {Calibrage par} Calibracion: Ron
Date [Datum] {Date} Fecha: 12/6/2012

Compliance Statement [Befolgung-Aussage] {Rapport de conformité} Declaración de la conformidad

To Whom It May Concern:

This is to certify that our products were manufactured, inspected, and accepted as conforming to your purchase order, and all applicable drawing and specification requirements. We further certify that the units have been tested and operate according to product performance specifications.

Director of Operations — Quality Manager

Form 0-569 English [German] {French} Spanish
Rev. F 1/17/02

QUALITROL®

Thermometer
Test Certificate / Prüfzertifikat/ Certificat de Test

50103836-1-1

Model No. / Modell-Nr. / N° de modèle	104-321-02
Order No. / Auftrags-Nr. / N° de commande	50103836 Line: 1
Serial No. / Serien-Nr. / N° de série	50103836-1-1 1 of 1
Customer / Kunde / Client	HYUNDAI HEAVY IND. CO. LTD.
Temp. Range / Temp. Bereich / Plage de mesure	0-160
Customer Purchase Order No. / Kunden-Auftrags-Nr. / N° de commande client	WA210TB5QT09
Gage Calibration Temp. / Kalibrierungstemp. / Temp. de calibrage de l'indicateur (°C)	60

- [x] Activity Below Minimum / Unterhalb Minimum / Test hors plage
- [ ] Minimum Temperature / Minimum Temperatur / Température Minimum
- [ ] Maximum Temperature / Maximum Temperatur / Température Maximum
- [x] Element Leak Test / Element Dichtheits Prüfung / Essai D'etanchete D'element 5.2 x 10 -8

Dial Range Bereich Plage de mesure	0-120	0-160	0-180	0-220	0-250	-20 - 160	-40 - 120
Spec: +/- °C	+/- 2.4	+/- 3.2	+/- 3.6	+/- 4.4	+/- 5.0	+/- 3.6	+/- 3.2

Switches set per / Schaltpunkte nach/ Réglage des seuils des contacts	Factory Default

(Switch Setting Accuracy +/-2% Dial Range unless otherwise stated on engineering drawing)
Dial readings recorded at actuation on rising temperature/de-actuation on falling temperature.
(Schaltpunkt-Genauigkeit +/-2% vom Skalenendwert wenn nicht anders beschrieben)
Einschaltwert bei Temp.-Anstieg, Ausschaltwert bei Temp.-Rückgang.
(Précision du réglage des seuils +/- 2% de la plage de mesure sauf indications contraires notées sur le plan Qualitrol)
Valeurs enregistrées: enclenchement pour une élévation de la température, déclenchement pour une diminution de la température.

Switch Set Point Schaltpunkt Seuil des contacts		Actual Switch Actuation / De-actuation Point Einschaltwert / Ausschaltwert seuil d'enclenchement / déclenchement		
SWT 1	80	SWT 1	80 /	70
SWT 2	90	SWT 2	90 /	80
SWT 3	120	SWT 3	120 /	110
SWT 4		SWT 4	/	
SWT 5		SWT 5	/	

Calibration Date / Kalibrierung Datum / Date De Calibrag 12/26/2012

Calibration By / Kalibrierung von / Calibrage par DC

High Potential Test Passed (60 second to ground) Hochspannungs-Prüfung (60 sec. gegen Erde) Test d'isolement (60 secondes à la terre):	V @ 0.5mA

Potentiometer Output / Ausgang / Sortie potentiomètre:

Range	mA Out @ 0°C	mA Out @ 40°C	mA Out @ 80°C	mA Out @ 120°C	mA Out @ 160°C
0-1mA					
4-20mA					

Completed By / Bearbeitet von / Rempli par HLW Date / Datum / Date 12/21/2012

PACKING CHECKLIST ACCESSORIES	
Base Dial	DAL-100-2
Dial	DAL-101-6 DAL-101-1
Plate	104-60-76 PLT-133-1
Connector	CON-661-13
Well	
Adaptor	
Wiring Label	09A01
Dial Kit	KIT-009-5
Transformer	
Coil	
Bulb Gskt	
Bulb Length (Inches)	15
Other	
	SLV-011-1

Form 0-622 English / German / French
Rev. N 4/4/08

QUALITROL®

Thermometer
Test Certificate / Prüfzertifikat/ Certificat de Test

50103836-2-1

Model No. / Modell-Nr. / N° de modèle	**104-321-02**	
Order No. / Auftrags-Nr. / N° de commande	**50103836**	Line: 2
Serial No. / Serien-Nr. / N° de série	**50103836-2-1**	1. of 1
Customer / Kunde / Client	**HYUNDAI HEAVY IND. CO. LTD.**	
Temp. Range / Temp. Bereich / Plage de mesure	**0-160**	
Customer Purchase Order No. / Kunden-Auftrags-Nr. / N° de commande client	WA210TB5QT09	
Gage Calibration Temp. / Kalibrierungstemp. / Temp. de calibrage de l'indicateur (°C)	**80**	

- [x] Activity Below Minimum / Unterhalb Minimum / Test hors plage
- [ ] Minimum Temperature / Minimum Temperatur / Température Minimum
- [ ] Maximum Temperature / Maximum Temperatur / Température Maximum
- [x] Element Leak Test / Element Dichtheits Prüfung / Essai D'etanchete D'element 2×10^{-8}

Dial Range Bereich Plage de mesure	0-120	0-160	0-180	0-220	0-250	-20 - 160	-40 - 120
Spec: +/- °C	+/- 2.4	+/- 3.2	+/- 3.6	+/- 4.4	+/- 5.0	+/- 3.6	+/- 3.2

Switches set per / Schaltpunkte nach/ Réglage des seuils des contacts	**Factory Default**

(Switch Setting Accuracy +/-2% Dial Range unless otherwise stated on engineering drawing)
Dial readings recorded at actuation on rising temperature/de-actuation on falling temperature.
(Schaltpunkt-Genauigkeit +/-2% vom Skalenendwert wenn nicht anders beschrieben)
Einschaltwert bei Temp.-Anstieg, Ausschaltwert bei Temp.-Rückgang.
(Précision du réglage des seuils +/- 2% de la plage de mesure sauf indications contraires notées sur le plan Qualitrol)
Valeurs enregistrées: enclenchement pour une élévation de la température, déclenchement pour une dimiution de la température.

Switch Set Point
Schaltpunkt
Seuil des contacts

SWT 1	80
SWT 2	90
SWT 3	120
SWT 4	
SWT 5	

Actual Switch Actuation / De-actuation Point
Einschaltwert / Ausschaltwert
seuil d'enclenchement / déclenchement

SWT 1	80	/	71
SWT 2	90	/	82
SWT 3	120	/	111
SWT 4		/	
SWT 5		/	

PACKING CHECKLIST ACCESSORIES		
Base Dial	DAL-100-2	
Dial	DAL-101-6	DAL-101-1
Plate	104-60-76	PLT-133-1
Connector	CON-661-13	
Well		
Adaptor		
Wiring Label	09A01	
Dial Kit	KIT-009-5	
Transformer		
Coil		
Bulb Gskt		
Bulb Length (Inches)	15	
Other		
	SLV-011-1	

Calibration Date / Kalibrierung Datum / Date De Calibrag: 12/27/2012

Calibration By / Kalibrierung von / Calibrage par: DC

High Potential Test Passed (60 second to ground) Hochspannungs-Prüfung (60 sec. gegen Erde) Test d'isolement (60 secondes à la terre):	V @ 0.5mA

Potentiometer Output / Ausgang / Sortie potentiomètre:

Range	mA Out @ 0°C	mA Out @ 40°C	mA Out @ 80°C	mA Out @ 120°C	mA Out @ 160°C
0-1mA					
4-20mA					

Completed By / Bearbeitet von / Rempli par: HLW

Date / Datum / Date: 12/21/2012

Form 0-622 English / German / French
Rev. N 4/4/08

Pressure Relief Device Test Certificate

Druckentlastungseinrichtung Prüfzeugnis
Décompression Test de certificat
Descompressão certificado de teste de dispositivos
De alivio de presión del dispositivo certificado de prueba
Pressure Relief Device certificato di prova 洩壓裝置測試證書
Устройства для сброса давления Сертификат

Qualitol Company LLC
1385 Fairport Rd
Fairport, NY 14550
USA
Phone: 1-585-586-1515
Fax: 1-585-377-0220
e-mail: info@qualitrolcorp.com
website: www.qualitrolcorp.com

Item No. [Artikelnummer] {Article} /No do tipo/Item No. (Artículo/Núm.Tipo) -Articolo N. Tipo.- 产品号 //Номер	**208-023-01**
Order No. [Auftrag-Nr.] {Numéro Commande.} Pedido No. (Núm. de pedido) -Conferma d'ordine N.- 订单号 //Номер заказа//	**50087351** Line: 1
Date [Datum] {Code Date} Data (Fecha) -Data- 日期 //Дата//	**12/6/2012**
Customer [Kunde] {Client} Cliente (Nombre del cliente) -Nome del cliente- 客户 //заказчик/ клиент //	**HYUNDAI HEAVY IND. CO. LTD.**
Customer Purchase Order No. [Kundenauftrag] {Commande Client} No. Pedido do cliente (Pedido del cliente) -Ordine del cliente- 客户采购订单号 //Номер контракта/приложения Заказчика//	**WA205TB5QT74** Pos 1
Serial No. [Seriennr.] {Numéro périodique} N° de série (Núm. de serie) -Numero di serie- 序列号 //Серийный номер//	**50087351-1-1**
Customer Part No. [Kunden-Teilenummer] {No Pièce De Client} Número da peça do cliente (Número de parte del cliente) -Numero del pezzo del cliente- 客户零件号 //Номер изделия Заказчика//	

Operates and Seals	Unit of Measure	Operating Specification	Operating Pressure
Funktioniert und Dichtung Fonctionne et joint Funciona e Seals Funciona y sello Работоспособность и изоляция Opera ed i sigilli 开启和密封	Maßeinheit Unité de mesure Unidade de Medida Unidad de Medida Единица измерения unità di misura 开启压力规格	Betriebsspezifikation Spécifications d'opération Especificação da Operação Especificación del funcionamiento рабочая спецификация Specificazione operativo 操作规格	Betriebsdruck Pression de fonctionnement pressão de operação Presión de funcionamiento рабочее давление Краска типа Pressione di funzionamento 开启压力
✓	*PSI	10 +/- 1	9.3 PSI
Pressure Relief Devices are operated twice to verify pressure and reseal.	Bar	0.69 +/- 0.069	0.64 Bar
Reading taken in PSI, then converted to other units of measure	kPa	68.9 +/- 6.89	64.1 kPa

☐ **C5M High or equivalent Paint per EN ISO-12944 for use in corrosive marine environment** 按照EN ISO-12944 C5M高或等同喷漆用于腐蚀性海洋环境
für den Einsatz in Offshore (korrosiven) Umgebungen
Pintura de alta ou equivalente C5M por EN ISO-12944 para uso em ambiente marinho
C5M Peinture secondaires ou l'équivalent selon la norme EN ISO 12944-pour une utilisation en milieu marin corrosif
Pintura C5M secundaria o su equivalente según la norma ISO-12944 para su uso en ambient marino corrosivo
C5M-Farbe oder gleichwertig EN ISO-12944 для использования в высоко коррозийных морских условиях
C5M vernice di alta o equivalente per EN-ISO 12944 per l'uso in ambienti corrosivi del l'ambiente marino

Alarm switches Qty: 1

[Warnungsschalter] {Commutateurs d'alarme} Interruptores de la alarma // Переключатели сигнала тревоги //

✓	**High Potential Test Passed (60 second to ground)** [Hochspannungs-Prüfung (60 sec. gegen Erde)] {Test d'isolement (60 secondes à la terre)} Alta prueba potencial pasajera (60 en segundo lugar a la tierra) Тест на высокую нагрузку пройден (60 секунд к земле) Test de alto potencial aprobado (60 segundos a tierra) 通过高电位测试（60秒对地）	2000 Vac @ 0.5mA

PACKING CHECKLIST ACCESSORIES

Semiphore	
Qty	Gasket
Connector	CON-604-5

This is to certify that our products were manufactured as specified on Qualitrol order confirmation and the units operate according to product performance specifications.

Hiermit wird bescheinigt, dass unsere Produkte hergestellt wurden, wie auf Qualitrol Auftragsbestätigung und die Geräte arbeiten nach dem Produkthaftungsgesetz Leistungsdaten.

Ceci est pour certifier que nos produits ont été manufacturés comme indiqué sur la confirmation de commande Qualitrol et les appareils fonctionnent selon les spécifications de performance du produit.

Isto é para certificar que os produtos foram fabricados conforme especificado no QUALITROL confirmação do pedido e as unidades funcionam de acordo com as especificações de desempenho do produto.

Esto es para certificar que nuestros productos han sido fabricados según lo especificado en la confirmación de la orden Qualitrol y las unidades funcionan de acuerdo a las especificaciones de rendimiento del producto.

Настоящим удостоверяется, что наши продукты были изготовлены, как указано на подтверждении заказа QUALITROL и устройства работают в соответствии со спецификацией изделия.

Si certifica che i nostri prodotti sono stati fabbricati, come specificato in conferma d'ordine Qualitrol e le unità di funzionare secondo le specifiche di prestazione del prodotto.

这是为了证明我们的产品是按照Qualitrol确认的订单以及产品性能规格制造

Richard Kloc
VP of Global Operations

Date [Datum] {Date} Data \\Дата\\ -Data-日期 12/4/2012
Signature [Unterschrift] {Signature} Assinatura \\Подпись\\ -Firma- 署名 GG/BAH

English [German] {French} Portuguese (Spanish) //Russian// - Italian- Chinese
Form 0-642 Rev. N 02 April. 2012

Qualitrol is a ISO 9001 system certified company. Information subject to change without notice.

QUALITROL Defining Reliability

Pressure Relief Device Test Certificate

Druckentlastungseinrichtung Prüfzeugnis
Décompression Test de certificat
Descompressão certificado de teste de dispositivos
De alivio de presión del dispositivo certificado de prueba
Pressure Relief Device certificato di prova 洩壓裝置測試證書
Устройства для сброса давления Сертификат

Qualitol Company LLC
1385 Fairport Rd
Fairport, NY 14550
USA
Phone: 1-585-586-1515
Fax: 1-585-377-0220
e-mail: info@qualitrolcorp.com
website: www.qualitrolcorp.com

Item No. [Artikelnummer] {Article} /No do tipo/Item No. (Artículo/Núm.Tipo) -Articolo N. Tipo.- 产品号 //Номер	**208-023-01**
Order No. [Auftrag-Nr.] {Numéro Commande.} Pedido No. (Núm. de pedido) -Conferma d'ordine N.- 订单号 //Номер заказа//	**50101299** Line: 10
Date [Datum] {Code Date} Data (Fecha) -Data- 日期 //Дата//	**12/6/2012**
Customer [Kunde] {Ciient} Cliente (Nombre del cliente) -Nome del cliente- 客户 //заказчик/ клиент //	**HYUNDAI HEAVY IND. CO. LTD.**
Customer Purchase Order No. [Kundenauftrag] {Commande Client} No. Pedido do cliente (Pedido del cliente) -Ordine del cliente- 客户采购订单号 //Номер контракта/приложения Заказчика//	**WA210TB5QT93** Pos 10
Serial No. [Seriennr.] {Numéro périodique} N° de série (Núm. de serie) -Numero di serie- 序列号 //Серийный номер//	**50101299-10-3**
Customer Part No. [Kunden-Teilenummer] {No Pièce De Client} Número da peça do cliente (Número de parte del cliente) -Numero del pezzo del cliente- 客户零件号 //Номер изделия Заказчика//	

Operates and Seals	Unit of Measure	Operating Specification	Operating Pressure
Funktioniert und Dichtung Fonctionne et joint Funciona e Seals Funciona y sello Работоспособность и изоляция Opera ed i sigilli 开启和密封	Maßeinheit Unité de mesure Unidade de Medida Unidad de Medida Единица измерения unità di misura 开启压力规格	Betriebsspezifikation Spécifications d'opération Especificação da Operação Especificación del funcionamiento рабочая спецификация Specificazione operativo 操作规格	Betriebsdruck Pression de fonctionnement pressão de operação Presión de funcionamiento рабочее давление Краска типа Pressione di funzionamento 开启压力
✓	***PSI**	**10 +/- 1**	**9.4 PSI**
Pressure Relief Devices are operated twice to verify pressure and reseal.	**Bar**	**0.69 +/- 0.069**	**0.65 Bar**
**Reading taken in PSI, then converted to other units of measure*	**kPa**	**68.9 +/- 6.89**	**64.8 kPa**

☐ **C5M High or equivalent Paint per EN ISO-12944 for use in corrosive marine environment** 按照EN ISO-12944 C5M高或等同喷漆用于腐蚀性海洋环境
für den Einsatz in Offshore (korrosiven) Umgebungen
Pintura de alta ou equivalente C5M por EN ISO-12944 para uso em ambiente marinho
C5M Peinture secondaires ou l'équivalent selon la norme EN ISO 12944-pour une utilisation en milieu marin corrosif
Pintura C5M secondaria o su equivalente según la norma ISO-12944 para su uso en ambient marino corrosivo
C5M или ее эквивалент EN ISO-12944 для использования в высоко коррозийных морских условиях
Pitture C5M secondarie di alta o equivalente per EN-ISO 12944 per l'uso in ambienti corrosivi del l'ambiente marino

Alarm switches Qty: 1

[Warnungsschalter] {Commutateurs d'alarme} Interruptores de la alarma // Переключатели сигнала тревоги //

✓	**High Potential Test Passed (60 second to ground)** [Hochspannungs-Prüfung (60 sec. gegen Erde)] {Test d'isolement (60 secondes à la terre)} Alta prueba potencial pasajera (60 en segundo lugar a la tierra) Тест на высокую нагрузку пройден (60 секунд к земле) Test de alto potencial aprobado (60 segundos a tierra) 通过高电位测试（60秒对地）	2000 Vac @ 0.5mA

PACKING CHECKLIST ACCESSORIES	
Semiphore	
Qty Gasket	
Connector	CON-604-5

This is to certify that our products were manufactured as specified on Qualitrol order confirmation and the units operate according to product performance specifications.

Hiermit wird bescheinigt, dass unsere Produkte hergestellt wurden, wie auf Qualitrol Auftragsbestätigung und die Geräte arbeiten nach dem Produkthaftungsgesetz Leistungsdaten.

Ceci est pour certifier que nos produits ont été manufacturés comme indiqué sur la confirmation de commande Qualitrol et les appareils fonctionnent selon les spécifications de performance du produit.

Isto é para certificar que os produtos foram fabricados conforme especificado no QUALITROL confirmação do pedido e as unidades funcionam de acordo com as especificações de desempenho do produto.

Esto es para certificar que nuestros productos han sido fabricados según lo especificado en la confirmación de la orden Qualitrol y las unidades funcionan de acuerdo a las especificaciones de rendimiento del producto.

Настоящим удостоверяется, что наши продукты были изготовлены, как указано на подтверждении заказа QUALITROL и устройства работают в соответствии со спецификацией изделия.

Si certifica che i nostri prodotti sono stati fabbricati, come specificato in conferma d'ordine Qualitrol e le unità di funzionare secondo le specifiche di prestazione del prodotto.

这是为了证明我们的产品是按照Qualitrol确认的订单以及产品性能规格制造

Richard Kloc
VP of Global Operations

Date [Datum] {Date} Data \\Дата\\ -Data-日期 12/4/2012
Signature [Unterschrift] {Signature} Assinatura \\Подпись\\ -Firma- 署名 GG/BAH

English [German] {French} Portuguese (Spanish) //Russian// - Italian- Chinese
Form 0-642 Rev. N 02 April. 2012

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QUALITROL Defining Reliability

Pressure Relief Device Test Certificate

Druckentlastungseinrichtung Prüfzeugnis
Décompression Test de certificat
Descompressão certificado de teste de dispositivos
De alivio de presión del dispositivo certificado de prueba
Pressure Relief Device certificato di prova 洩壓裝置測試證書
Устройства для сброса давления Сертификат

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website: www.qualitrolcorp.com

Item No. [Artikelnummer] {Article} /No do tipo/Item No. (Artículo/Núm.Tipo) -Articolo N. Tipo.- 产品号 //Номер	**208-023-01**
Order No. [Auftrag-Nr.] {Numéro Commande.} Pedido No. (Núm. de pedido) -Conferma d'ordine N.- 订单号 //Номер заказа//	**50101299** Line: 11
Date [Datum] {Code Date} Data (Fecha) -Data- 日期 //Дата//	**12/6/2012**
Customer [Kunde] {Client} Cliente (Nombre del cliente) -Nome del cliente- 客户 //заказчик/ клиент //	**HYUNDAI HEAVY IND. CO. LTD.**
Customer Purchase Order No. [Kundenauftrag] {Commande Client} No. Pedido do cliente (Pedido del cliente) -Ordine del cliente- 客户采购订单号 //Номер контракта/приложения Заказчика//	**WA210TB5QT93** Pos 11
Serial No. [Seriennr.] {Numéro périodique} N° de série (Núm. de serie) -Numero di serie- 序列号 //Серийный номер//	**50101299-11-1**
Customer Part No. [Kunden-Teilenummer] {No Pièce De Client} Número da peça do cliente (Número de parte del cliente) -Numero del pezzo del cliente- 客户零件号 //Номер изделия Заказчика//	

Operates and Seals	Unit of Measure	Operating Specification	Operating Pressure
Funktioniert und Dichtung Fonctionne et joint Funciona e Seals Funciona y sello Работоспособность и изоляция Opera ed i sigilli 开启和密封	Maßeinheit Unité de mesure Unidade de Medida Unidad de Medida Единица измерения unità di misura 开启压力规格	Betriebsspezifikation Spécifications d'opération Especificação da Operação Especificación del funcionamiento рабочая спецификация Specificazione operativo 操作规格	Betriebsdruck Pression de fonctionnement pressão de operação Presión de funcionamiento рабочее давление Краска типа Pressione di funzionamento 开启压力
✓	*PSI	10 +/- 1	9.4 PSI
Pressure Relief Devices are operated twice to verify pressure and reseal.	Bar	0.69 +/- 0.069	0.65 Bar
Reading taken in PSI, then converted to other units of measure	kPa	68.9 +/- 6.89	64.8 kPa

☐ **C5M High or equivalent Paint per EN ISO-12944 for use in corrosive marine environment** 按照EN ISO-12944 C5M高或等同喷漆用于腐蚀性海洋环境
für den Einsatz in Offshore (korrosiven) Umgebungen
Pintura de alta ou equivalente C5M por EN ISO-12944 para uso em ambiente marinho corrosivo
C5M Peinture secondaires ou l'équivalent selon la norme EN ISO 12944-pour une utilisation en milieu marin corrosif
Pintura C5M secondaria o su equivalente según la norma ISO-12944 para su uso en ambient marino corrosivo
Конечная или ее эквивалент EN ISO-12944 для использования в высоко коррозийных морских условиях
Conformità di alta o equivalente per EN-ISO 12944 per l'uso in ambienti corrosivi del l'ambiente marino

Alarm switches Qty: 1

[Warnungsschalter] {Commutateurs d'alarme} Interruptores de la alarma // Переключатели сигнала тревоги //

✓	**High Potential Test Passed (60 second to ground)** [Hochspannungs-Prüfung (60 sec. gegen Erde)] {Test d'isolement (60 secondes à la terre)} Alta prueba potencial pasajera (60 en segundo lugar a la tierra) Тест на высокую нагрузку пройден (60 секунд к земле) Test de alto potencial aprobado (60 segundos a tierra) 通过高电位测试（60秒对地）	2000 Vac @ 0.5mA

PACKING CHECKLIST ACCESSORIES

Semiphore	
Qty	Gasket
Connector	CON-604-5

This is to certify that our products were manufactured as specified on Qualitrol order confirmation and the units operate according to product performance specifications.

Hiermit wird bescheinigt, dass unsere Produkte hergestellt wurden, wie auf Qualitrol Auftragsbestätigung und die Geräte arbeiten nach dem Produkthaftungsgesetz Leistungsdaten.

Ceci est pour certifier que nos produits ont été manufacturés comme indiqué sur la confirmation de commande Qualitrol et les appareils fonctionnent selon les spécifications de performance du produit.

Isto é para certificar que os produtos foram fabricados conforme especificado no QUALITROL confirmação do pedido e as unidades funcionam de acordo com as especificações de desempenho do produto.

Esto es para certificar que nuestros productos han sido fabricados según lo especificado en la confirmación de la orden Qualitrol y las unidades funcionan de acuerdo a las especificaciones de rendimiento del producto.

Настоящим удостоверяется, что наши продукты были изготовлены, как указано на подтверждении заказа QUALITROL и устройства работают в соответствии со спецификацией изделия.

Si certifica che i nostri prodotti sono stati fabbricati, come specificato in conferma d'ordine Qualitrol e le unità di funzionare secondo le specifiche di prestazione del prodotto.

这是为了证明我们的产品是按照Qualitrol确认的订单以及产品性能规格制造

Richard Kloc
VP of Global Operations

Date [Datum] {Date} Data \\Дата\\ -Data-日期 12/4/2012
Signature [Unterschrift] {Signature} Assinatura \\Подпись\\ -Firma- 署名 GG/BAH

English [German] {French} Portuguese (Spanish) //Russian// - Italian- Chinese
Form 0-642 Rev. N 02 April. 2012

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QUALITROL Defining Reliability

Pressure Relief Device Test Certificate

Druckentlastungseinrichtung Prüfzeugnis
Décompression Test de certificat
Descompressão certificado de teste de dispositivos
De alivio de presión del dispositivo certificado de prueba
Pressure Relief Device certificato di prova 洩壓裝置測試證書
Устройства для сброса давления Сертификат

Qualitol Company LLC
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Fairport, NY 14550
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Phone: 1-585-586-1515
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website: www.qualitrolcorp.com

Item No. [Artikelnummer] {Article} /No do tipo/Item No. (Artículo/Núm.Tipo) -Articolo N. Tipo.- 产品号 //Номер	**208-023-01**
Order No. [Auftrag-Nr.] {Numéro Commande.} Pedido No. (Núm. de pedido) -Conferma d'ordine N.- 订单号 //Номер заказа//	**50104081** Line: 7
Date [Datum] {Code Date} Data (Fecha) -Data- 日期 //Дата//	**11/13/2012**
Customer [Kunde] {Client} Cliente (Nombre del cliente) -Nome del cliente- 客户 //заказчик/ клиент //	**HYUNDAI HEAVY IND. CO. LTD.**
Customer Purchase Order No. [Kundenauftrag] {Commande Client} No. Pedido do cliente (Pedido del cliente) -Ordine del cliente- 客户采购订单号 //Номер контракта/приложения Заказчика//	**WA210TB5QT12** Pos 7
Serial No. [Seriennr.] {Numéro périodique} N° de série (Núm. de serie) -Numero di serie- 序列号 //Серийный номер//	**50104081-7-8**
Customer Part No. [Kunden-Teilenummer] {No Pièce De Client} Número da peça do cliente (Número de parte del cliente) -Numero del pezzo del cliente- 客户零件号 //Номер изделия Заказчика//	

Operates and Seals	Unit of Measure	Operating Specification	Operating Pressure
Funktioniert und Dichtung Fonctionne et joint Funciona e Seals Funciona y sello Работоспособность и изоляция Opera ed i sigilli 开启和密封	Maßeinheit Unité de mesure Unidade de Medida Unidad de Medida Единица измерения unità di misura 开启压力规格	Betriebsspezifikation Spécifications d'opération Especificação da Operação Especificación del funcionamiento рабочая спецификация Specificazione operativo 操作规格	Betriebsdruck Pression de fonctionnement pressão de operação Presión de funcionamiento рабочее давление Краска типа Pressione di funzionamento 开启压力
✓	*PSI	10 +/- 1	9.5 PSI
Pressure Relief Devices are operated twice to verify pressure and reseal.	Bar	0.69 +/- 0.069	0.65 Bar
Reading taken in PSI, then converted to other units of measure	kPa	68.9 +/- 6.89	65.5 kPa

☐ **C5M High or equivalent Paint per EN ISO-12944 for use in corrosive marine environment** 按照EN ISO-12944 C5M高或等同喷漆用于腐蚀性海洋环境
für den Einsatz in Offshore (korrosiven) Umgebungen
C5M Peinture secondaires ou l'équivalent selon la norme EN ISO 12944-pour une utilisation en milieu marin corrosif
Pintura de alta ou equivalente C5M por EN ISO-12944 para uso em ambiente marinho
Pintura C5M secundaria o su equivalente según la norma ISO-12944 para su uso en ambient corrosivo
C5M vernice di alta o equivalente per EN-ISO 12944 per l'uso in ambienti corrosivi del mare
или ее эквивалент EN ISO-12944 для использования в высоко коррозийных и морских условиях
l'ambiente marino

Alarm switches Qty: 1

[Warnungsschalter] {Commutateurs d'alarme} Interruptores de la alarma // Переключатели сигнала тревоги //

✓	**High Potential Test Passed (60 second to ground)** [Hochspannungs-Prüfung (60 sec. gegen Erde)] {Test d'isolement (60 secondes à la terre)} Alta prueba potencial pasajera (60 en segundo lugar a la tierra) Тест на высокую нагрузку пройден (60 секунд к земле) Test de alto potencial aprobado (60 segundos a tierra) 通过高电位测试（60秒对地）	2000 Vac @ 0.5mA

PACKING CHECKLIST ACCESSORIES
Semiphore
Qty Gasket
Connector CON-604-5

This is to certify that our products were manufactured as specified on Qualitrol order confirmation and the units operate according to product performance specifications.

Hiermit wird bescheinigt, dass unsere Produkte hergestellt wurden, wie auf Qualitrol Auftragsbestätigung und die Geräte arbeiten nach dem Produkthaftungsgesetz Leistungsdaten.

Ceci est pour certifier que nos produits ont été manufacturés comme indiqué sur la confirmation de commande Qualitrol et les appareils fonctionnent selon les spécifications de performance du produit.

Isto é para certificar que os produtos foram fabricados conforme especificado no QUALITROL confirmação do pedido e as unidades funcionam de acordo com as especificações de desempenho do produto.

Esto es para certificar que nuestros productos han sido fabricados según lo especificado en la confirmación de la orden Qualitrol y las unidades funcionan de acuerdo a las especificaciones de rendimiento del producto.

Настоящим удостоверяется, что наши продукты были изготовлены, как указано на подтверждении заказа QUALITROL и устройства работают в соответствии со спецификацией изделия.

Si certifica che i nostri prodotti sono stati fabbricati, come specificato in conferma d'ordine Qualitrol e le unità di funzionare secondo le specifiche di prestazione del prodotto.

这是为了证明我们的产品是按照Qualitrol确认的订单以及产品性能规格制造

Richard Kloc
VP of Global Operations

Date [Datum] {Date} Data \\Дата\\ -Data-日期 11/9/2012
Signature [Unterschrift] {Signature} Assinatura \\Подпись\\ -Firma- 署名 MK/BH

English [German] {French} Portuguese (Spanish) //Russian// - Italian- Chinese
Form 0-642 Rev. N 02 April. 2012

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QUALITROL Defining Reliability

Pressure Relief Device Test Certificate

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Décompression Test de certificat
Descompressão certificado de teste de dispositivos
De alivio de presión del dispositivo certificado de prueba
Pressure Relief Device certificato di prova 洩壓裝置測試證書
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e-mail: info@qualitrolcorp.com
website: www.qualitrolcorp.com

Item No. [Artikelnummer] {Article} /No do tipo/Item No. (Artículo/Núm.Tipo) -Articolo N. Tipo.- 产品号 //Номер	**208-023-01**
Order No. [Auftrag-Nr.] {Numéro Commande.} Pedido No. (Núm. de pedido) -Conferma d'ordine N.- 订单号 //Номер заказа//	**50104081** Line: 7
Date [Datum] {Code Date} Data (Fecha) -Data- 日期 //Дата//	**11/13/2012**
Customer [Kunde] {Client} Cliente (Nombre del cliente) -Nome del cliente- 客户 //заказчик/ клиент //	**HYUNDAI HEAVY IND. CO. LTD.**
Customer Purchase Order No. [Kundenauftrag] {Commande Client} No. Pedido do cliente (Pedido del cliente) -Ordine del cliente- 客户采购订单号 //Номер контракта/приложения Заказчика//	**WA210TB5QT12** Pos 7
Serial No. [Seriennr.] {Numéro périodique} Nº de série (Núm. de serie) -Numero di serie- 序列号 //Серийный номер//	**50104081-7-10**
Customer Part No. [Kunden-Teilenummer] {No Pièce De Client} Número da peça do cliente (Número de parte del cliente) -Numero del pezzo del cliente- 客户零件号 //Номер изделия Заказчика//	

Operates and Seals	Unit of Measure	Operating Specification	Operating Pressure
Funktioniert und Dichtung Fonctionne et joint Funciona e Seals Funciona y sello Работоспособность и изоляция Opera ed i sigilli 开启和密封	Maßeinheit Unité de mesure Unidade de Medida Unidad de Medida Единица измерения unità di misura 开启压力规格	Betriebsspezifikation Spécifications d'opération Especificação da Operação Especificación del funcionamiento рабочая спецификация Specificazione operativo 操作规格	Betriebsdruck Pression de fonctionnement pressão de operação Presión de funcionamiento рабочее давление Краска типа Pressione di funzionamento 开启压力
✓	***PSI**	**10 +/- 1**	**9.1 PSI**
Pressure Relief Devices are operated twice to verify pressure and reseal.	**Bar**	**0.69 +/- 0.069**	**0.63 Bar**
**Reading taken in PSI, then converted to other units of measure*	**kPa**	**68.9 +/- 6.89**	**62.7 kPa**

☐ **C5M High or equivalent Paint per EN ISO-12944 for use in corrosive marine environment** 按照EN ISO-12944 C5M高或等同喷漆用于腐蚀性海洋环境
für den Einsatz in Offshore (korrosiven) Umgebungen
C5M Peinture secondaires ou l'équivalent selon la norme EN ISO 12944-pour une utilisation en milieu marin corrosif
Pintura de alta ou equivalente C5M por EN ISO-12944 para uso em ambiente marinho
Pintura C5M alta o equivalente según la norma ISO-12944 para su uso en ambient o marino corrosivo
C5M High или ее эквивалент EN ISO-12944 для использования в высоко коррозийной морской условиях
C5M vernice di alta o equivalente per EN-ISO 12944 per l'uso in ambienti corrosivi del l'ambiente marino

Alarm switches Qty: 1

[Warnungsschalter] {Commutateurs d'alarme} Interruptores de la alarma // Переключатели сигнала тревоги //

✓	**High Potential Test Passed (60 second to ground)** [Hochspannungs-Prüfung (60 sec. gegen Erde)] {Test d'isolement (60 secondes à la terre)} Alta prueba potencial pasajera (60 en segundo lugar a la tierra) Тест на высокую нагрузку пройден (60 секунд к земле) Test de alto potencial aprobado (60 segundos a tierra) 通过高电位测试（60秒对地）	2000 Vac @ 0.5mA

PACKING CHECKLIST ACCESSORIES
Semiphore
Qty Gasket
Connector **CON-604-5**

This is to certify that our products were manufactured as specified on Qualitrol order confirmation and the units operate according to product performance specifications.

Hiermit wird bescheinigt, dass unsere Produkte hergestellt wurden, wie auf Qualitrol Auftragsbestätigung und die Geräte arbeiten nach dem Produkthaftungsgesetz Leistungsdaten.

Ceci est pour certifier que nos produits ont été manufacturés comme indiqué sur la confirmation de commande Qualitrol et les appareils fonctionnent selon les spécifications de performance du produit.

Isto é para certificar que os produtos foram fabricados conforme especificado no QUALITROL confirmação do pedido e as unidades funcionam de acordo com as especificações de desempenho do produto.

Esto es para certificar que nuestros productos han sido fabricados según lo especificado en la confirmación de la orden Qualitrol y las unidades funcionan de acuerdo a las especificaciones de rendimiento del producto.

Настоящим удостоверяется, что наши продукты были изготовлены, как указано на подтверждении заказа QUALITROL и устройства работают в соответствии со спецификацией изделия.

Si certifica che i nostri prodotti sono stati fabbricati, come specificato in conferma d'ordine Qualitrol e le unità di funzionare secondo le specifiche di prestazione del prodotto.

这是为了证明我们的产品是按照Qualitrol确认的订单以及产品性能规格制造

Richard Kloc
VP of Global Operations

Date [Datum] {Date} Data \\Дата\\ -Data-日期 11/9/2012
Signature [Unterschrift] {Signature} Assinatura \\Подпись\\ -Firma- 署名 MK/BH

English [German] {French} Portuguese (Spanish) //Russian// - Italian- Chinese
Form 0-642 Rev. N 02 April. 2012

Qualitrol is a ISO 9001 system certified company. Information subject to change without notice.

QUALITROL Defining Reliability

QUALITROL®

Qualitrol LLC
1385 Fairport Rd.
Fairport, NY 14534 USA
Tel: 1-585-586-1515

900/910 Series Rapid Pressure Rise Relay

[900/910 Reihen-schnelle Druck-Aufstiegs-Relais-Test-Bescheinigung]
{ Certificat D'essai Rapide de Relais D'élévation de Pression de 900/910 Série}
Certificado de Prueba Rápido del Relais de la Subida de la Presión de 900/910 Serie

Model No.[Modell-Nr.] {No de modele} No. de modelo	900-003-02	
Order No. [Auftrags-Nr.] {No de commande} No. de orden de ventas	50072999	Line: 11
Serial No. [Geräte-Serien-Nr.] {N° de série} No. de serie	50072999-11-1	1 of 3
Customer [Kunde] {Client} Cliente	HYUNDAI HEAVY IND. CO. LTD.	
Date Code [Datums-Code] {Code Date} Codigo de fecha	5/10/2012	
Customer Part No. [Kunde Teil-Nr.] {No Pièce De Client} No. de Pieza Del Cliente		Position 1
Customer Purchase Order No. [Auftrags-Nr.] {No de commande} No. de orden de compra	WA111TB5QT62	

PACKING CHECKLIST ACCESSORIES
Tag
Vent
Connector Cap
Instructions
Connector

Operational Verification [Überprüfungsrichtlinie] {Essais effectués:} Verificacion de la Operación

(Product Performance Specification PPS-9)

Test Sequence [Testsequenz] {Séquence de test} Secuencia de prueba	Starting Pressure (PSIG) [Anfangsdruck] {Pression initiale} Presión inicial		Pressure Rise Rate [Druck-Aufstiegs-Rate] {Taux d'élévation de pression} Tarifa de la subida de la presión		Accept Limits [Nehmen Sie Begrenzungen an] {Acceptez les limites} Acepte los límites		Time (seconds) [Zeit (Sekunden)] { Temps (secondes) } Tiempo (segundos)
Series	900	910	900	910	900	910	
1	0	[illegible]	5	[illegible]	0.40 - 0.54	[illegible]	**0.410**
2	5	[illegible]	5	[illegible]	0.38 - 0.56	[illegible]	**0.390**
3	10	[illegible]	5	[illegible]	0.38 - 0.56	[illegible]	**0.430**
4	0	[illegible]	5	0.725	0.38 - 0.56	[illegible]	**0.450**
5	0	[illegible]	0.725	[illegible]	<15	[illegible]	**3.940**
6	0	[illegible]	0.22	[illegible]	>30	[illegible]	**30.010**
7	na	[illegible]	na	[illegible]	na	[illegible]	
8	na	[illegible]	na	[illegible]	na	[illegible]	

Note: Allow a 45 second delay after each test sequence and at least 1.5 minutes after sequence 3 and 7.
[Bemerkung]: Nach jeder Testsequenz ist eine Pause von 45 Sekunden und nach Sequenz 3 und 7 eine Pause von mindestens 1.5 Minuten erforderlich.
{Note}: le délai après chaque séquence est de 45 secondes sauf après la séquence 3 et 7: au moins 1,5 minute.
Nota: Permita un retardo de 45 segundos después de cada secuencia de prueba y por lo menos de 1,5 minutos después de la secuencia.

Completed By [Bearbeitet von] {Rempli par} Terminado cerca	DN	Calibration by [Kalibrieung von] {Calibrage par} Calibracion	GL	Date [Datum] {Date} Fecha	5/10/2012

Compliance Statement [Befolgung-Aussage] {Rapport de conformité} Declaración de la conformidad

To Whom It May Concern:

This is to certify that our products were manufactured, inspected, and accepted as conforming to your purchase order, and all applicable drawing and specification requirements. We further certify that the units have been tested and operate according to product performance specifications.

Director of Operations — Quality Manager

Form 0-777 English [German] {French} Spanish
Rev. C 11/14/2008

QUALITROL®

Qualitrol LLC
1385 Fairport Rd.
Fairport, NY 14534 USA
Tel: 1-585-586-1515

900/910 Series Rapid Pressure Rise Relay

[900/910 Reihen-schnelle Druck-Aufstiegs-Relais-Test-Bescheinigung]
{ Certificat D'essai Rapide de Relais D'élévation de Pression de 900/910 Série}
Certificado de Prueba Rápido del Relais de la Subida de la Presión de 900/910 Serie

Model No.[Modell-Nr.] {No de modele} No. de modelo	**900-003-02**	
Order No. [Auftrags-Nr.] {No de commande} No. de orden de ventas	**50085795**	Line: 9
Serial No. [Geräte-Serien-Nr.] {N° de série} No. de serie	**50085795-9-3**	3 of 4
Customer [Kunde] {Client} Cliente	**HYUNDAI HEAVY IND. CO. LTD.**	
Date Code [Datums-Code] {Code Date} Codigo de fecha	**7/9/2012**	
Customer Part No. [Kunde Teil-Nr.] {No Pièce De Client} No. de Pieza Del Cliente		Position
Customer Purchase Order No. [Auftrags-Nr.] {No de commande} No. de orden de compra		WA204TB5QT58

PACKING CHECKLIST ACCESSORIES
Tag
Vent
Connector Cap
Instructions
Connector

Operational Verification [Überprüfungsrichtlinie] {Essais effectués:} Verificacion de la Operación

(Product Performance Specification PPS-9)

Test Sequence [Testsequenz] {Séquence de test} Secuencia de prueba	Starting Pressure (PSIG) [Anfangsdruck] {Pression initiale} Presión inicial		Pressure Rise Rate [Druck-Aufstiegs-Rate] {Taux d'élévation de pression} Tarifa de la subida de la presión		Accept Limits [Nehmen Sie Begrenzungen an] {Acceptez les limites} Acepte los límites		Time (seconds) [Zeit (Sekunden)] { Temps (secondes) } Tiempo (segundos)
Series	900	910	900	910	900	910	
1	0	0	5	5	0.40 - 0.54	0.26 - 0.34	**0.470**
2	5	5	5	5	0.38 - 0.56	0.26 - 0.34	**0.480**
3	10	10	5	5	0.38 - 0.56	0.26 - 0.34	**0.560**
4	0	0	5	0.725	0.38 - 0.56	2.0 - 3.5	**0.480**
5	0	0	0.725	0.22	<15	2.0 - 3.5	**4.040**
6	0	0	0.22	0.22	>30	2.0 - 3.5	**30.010**
7	na	na	na	0.40	na	2.0 - 3.5	
8	na	0	na	0.22	na	2.0	

Note: Allow a 45 second delay after each test sequence and at least 1.5 minutes after sequence 3 and 7.
[Bemerkung]: Nach jeder Testsequenz ist eine Pause von 45 Sekunden und nach Sequenz 3 und 7 eine Pause von mindestens 1.5 Minuten erforderlich.
{Note}: le délai après chaque séquence est de 45 secondes sauf après la séquence 3 et 7: au moins 1,5 minute.
Nota: Permita un retardo de 45 segundos después de cada secuencia de prueba y por lo menos de 1,5 minutos después de la secuencia.

Completed By [Bearbeitet von] {Rempli par} Terminado cerca: DN
Calibration by [Kalibrieung von] {Calibrage par} Calibracion: GL
Date [Datum] {Date} Fecha: 7/9/2012

Compliance Statement [Befolgung-Aussage] {Rapport de conformité} Declaración de la conformidad

To Whom It May Concern:

This is to certify that our products were manufactured, inspected, and accepted as conforming to your purchase order, and all applicable drawing and specification requirements. We further certify that the units have been tested and operate according to product performance specifications.

Director of Operations

Quality Manager

Form 0-777 English [German] {French} Spanish
Rev. C 11/14/2008

QUALITROL®

Qualitrol LLC
1385 Fairport Rd.
Fairport, NY 14534 USA
Tel: 1-585-586-1515

900/910 Series Rapid Pressure Rise Relay

[900/910 Reihen-schnelle Druck-Aufstiegs-Relais-Test-Bescheinigung]
{ Certificat D'essai Rapide de Relais D'élévation de Pression de 900/910 Série}
Certificado de Prueba Rápido del Relais de la Subida de la Presión de 900/910 Serie

Model No.[Modell-Nr.] {No de modele} No. de modelo	900-003-02	
Order No. [Auftrags-Nr.] {No de commande} No. de orden de ventas	50101299	Line: 1
Serial No. [Geräte-Serien-Nr.] {N° de série} No. de serie	50101299-1-1	1 of 1
Customer [Kunde] {Client} Cliente	HYUNDAI HEAVY IND. CO. LTD.	
Date Code [Datums-Code] {Code Date} Codigo de fecha	12/6/2012	
Customer Part No. [Kunde Teil-Nr.] {No Pièce De Client} No. de Pieza Del Cliente		Position
Customer Purchase Order No. [Auftrags-Nr.] {No de commande} No. de orden de compra		WA210TB5QT93

PACKING CHECKLIST ACCESSORIES
Tag
Vent
Connector Cap
Instructions
Connector

Operational Verification [Überprüfungsrichtlinie] {Essais effectués:} Verificacion de la Operación

(Product Performance Specification PPS-9)

Test Sequence [Testsequenz] {Séquence de test} Secuencia de prueba	Starting Pressure (PSIG) [Anfangsdruck] {Pression initiale} Presión inicial		Pressure Rise Rate [Druck-Aufstiegs-Rate] {Taux d'élévation de pression} Tarifa de la subida de la presión		Accept Limits [Nehmen Sie Begrenzungen an] {Acceptez les limites} Acepte los límites		Time (seconds) [Zeit (Sekunden)] { Temps (secondes) } Tiempo (segundos)
Series	900	910	900	910	900	910	
1	0	0	5	5	0.40 - 0.54	0.40 - 0.54	**0.470**
2	5	5	5	5	0.38 - 0.56	0.38 - 0.56	**0.400**
3	10	10	5	5	0.38 - 0.56	0.38 - 0.56	**0.460**
4	0	0	5	0.725	0.38 - 0.56	20 - 35	**0.540**
5	0	0	0.725	0.22	<15	25 - 35	**4.980**
6	0	0	0.22	0.22	>30	25 - 35	**30.010**
7	na	10	na	0.22	na	25 - 35	
8	na	0	na	0.22	na	>10	

Note: Allow a 45 second delay after each test sequence and at least 1.5 minutes after sequence 3 and 7.
[Bemerkung]: Nach jeder Testsequenz ist eine Pause von 45 Sekunden und nach Sequenz 3 und 7 eine Pause von mindestens 1.5 Minuten erforderlich.
{Note}: le délai après chaque séquence est de 45 secondes sauf après la séquence 3 et 7: au moins 1,5 minute.
Nota: Permita un retardo de 45 segundos después de cada secuencia de prueba y por lo menos de 1,5 minutos después de la secuencia.

Completed By [Bearbeitet von] {Rempli par} Terminado cerca	Calibration by [Kalibrieung von] {Calibrage par} Calibracion	Date [Datum] {Date} Fecha
NR	GL	12/6/2012

Compliance Statement
[Befolgung-Aussage]
{Rapport de conformité}
Declaración de la conformidad

To Whom It May Concern:

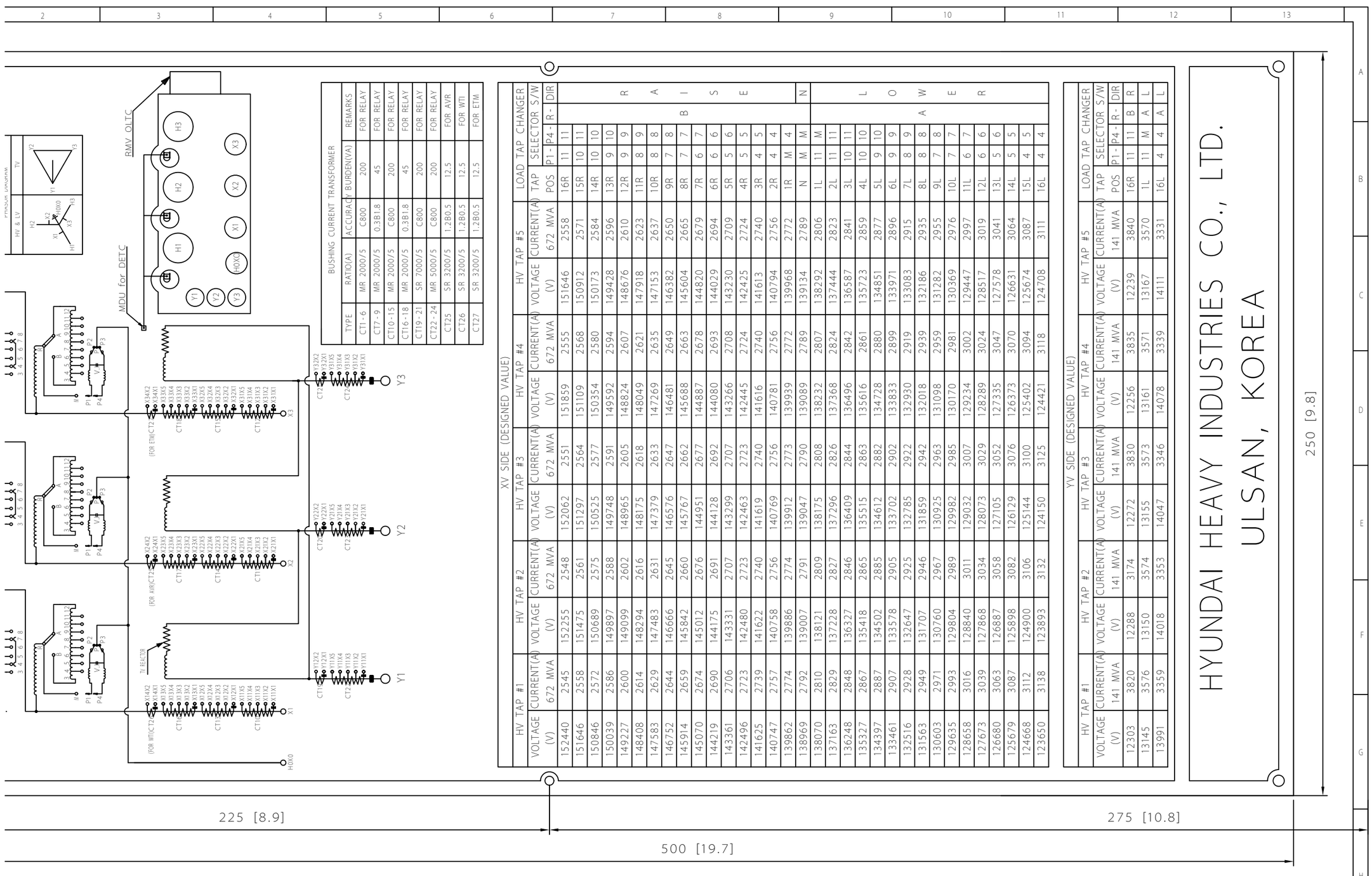
This is to certify that our products were manufactured, inspected, and accepted as conforming to your purchase order, and all applicable drawing and specification requirements. We further certify that the units have been tested and operate according to product performance specifications.

VP Global Operations

Quality Manager

Form 0-777 English [German] {French} Spanish
Rev. C 11/14/2008

EXHIBIT B



BUSHING CURRENT TRANSFORMER			
TYPE	RATIO(A)	ACCURACY BURDEN(VA)	REMARKS
CT1 - 6	MR 2000/5	C800 200	FOR RELAY
CT7 - 9	MR 2000/5	0.3B1.8 45	FOR RELAY
CT10 - 15	MR 2000/5	C800 200	FOR RELAY
CT16 - 18	MR 2000/5	0.3B1.8 45	FOR RELAY
CT19 - 21	SR 7000/5	C800 200	FOR RELAY
CT22 - 24	MR 5000/5	C800 200	FOR RELAY
CT25	SR 3200/5	1.2B0.5 12.5	FOR AVR
CT26	SR 3200/5	1.2B0.5 12.5	FOR WTI
CT27	SR 3200/5	1.2B0.5 12.5	FOR ETM

XV SIDE (DESIGNED VALUE)

HV TAP #1 VOLTAGE (V)	HV TAP #1 CURRENT(A) 672 MVA	HV TAP #2 VOLTAGE (V)	HV TAP #2 CURRENT(A) 672 MVA	HV TAP #3 VOLTAGE (V)	HV TAP #3 CURRENT(A) 672 MVA	HV TAP #5 VOLTAGE (V)	HV TAP #5 CURRENT(A) 672 MVA	LOAD TAP CHANGER TAP POS	LOAD TAP CHANGER SELECTOR S/W P1 - P4	LOAD TAP CHANGER SELECTOR S/W R - DIR
152440	2545	152255	2548	152062	2551	151646	2558	16R	11	11
151646	2558	151475	2561	151297	2564	150912	2571	15R	10	11
150846	2572	150689	2575	150525	2577	150173	2584	14R	10	10
150039	2586	149897	2588	149748	2591	149428	2596	13R	9	10
149227	2600	149099	2602	148965	2605	148676	2610	12R	9	9
148408	2614	148294	2616	148175	2618	147918	2623	11R	8	9
147583	2629	147483	2631	147379	2633	147153	2637	10R	8	8
146752	2644	146666	2645	146576	2647	146382	2650	9R	7	8
145914	2659	145842	2660	145767	2662	145604	2665	8R	7	7
145070	2674	145012	2676	144951	2677	144820	2679	7R	6	7
144219	2690	144175	2691	144128	2692	144029	2694	6R	6	6
143361	2706	143331	2707	143299	2707	143230	2709	5R	5	6
142496	2723	142480	2723	142463	2723	142425	2724	4R	5	5
141625	2739	141622	2740	141619	2740	141613	2740	3R	4	5
140747	2757	140758	2756	140769	2756	140794	2756	2R	4	4
139862	2774	139886	2774	139912	2773	139968	2772	1R	M	4
138969	2792	139007	2791	139047	2790	139134	2789	N	M	M
138070	2810	138121	2809	138175	2808	138292	2806	1L	11	M
137163	2829	137228	2827	137296	2826	137444	2823	2L	11	11
136248	2848	136327	2846	136409	2844	136587	2841	3L	10	11
135327	2867	135418	2865	135515	2863	135723	2859	4L	10	10
134397	2887	134502	2885	134612	2882	134851	2877	5L	9	10
133461	2907	133578	2905	133702	2902	133833	2899	6L	9	9
132516	2928	132647	2925	132785	2922	132930	2919	7L	8	9
131563	2949	131707	2946	131859	2942	132018	2939	8L	8	8
130603	2971	130760	2967	130925	2963	131098	2959	9L	7	8
129635	2993	129804	2989	129982	2985	130170	2981	10L	7	7
128658	3016	128840	3011	129032	3007	129234	3002	11L	6	7
127673	3039	127868	3034	128073	3029	128289	3024	12L	6	6
126680	3063	126887	3058	127105	3052	127335	3047	13L	5	6
125679	3087	125898	3082	126129	3076	126373	3070	14L	5	5
124668	3112	124900	3106	125144	3100	125402	3094	15L	4	5
123650	3138	123893	3132	124150	3125	124421	3118	16L	4	4

YV SIDE (DESIGNED VALUE)

HV TAP #1 VOLTAGE (V)	HV TAP #1 CURRENT(A) 141 MVA	HV TAP #2 VOLTAGE (V)	HV TAP #2 CURRENT(A) 141 MVA	HV TAP #3 VOLTAGE (V)	HV TAP #3 CURRENT(A) 141 MVA	HV TAP #5 VOLTAGE (V)	HV TAP #5 CURRENT(A) 141 MVA	LOAD TAP CHANGER TAP POS	LOAD TAP CHANGER SELECTOR S/W P1 - P4	LOAD TAP CHANGER SELECTOR S/W R - DIR
12303	3820	12288	3174	12272	3830	12239	3840	16R	11	11
13145	3576	13150	3574	13155	3573	13167	3570	1L	11	M
13991	3359	14018	3353	14047	3346	14111	3331	16L	4	4

* NOTE

1. MATERIAL : STAINLESS STEEL
2. THICKNESS : 1.0 mm [0.039 in]
3. NATURAL FACE, DARK LETTER AND LINE
4. STANDARD : IEEEI C57.12.00

APP	H.O. SONG	2	Corrected BCT number	APP	3
CHK	J.H. KANG			CHK	
DSN	E.S. SHIN 2013.01.23			DSN	

DSN	CHK	APP	PROJ.	3RD	TITLE : 3PH 60HZ 403/535/672MVA 345/138/13.2KV CONNECTION PLATE		
			UNIT	mm			
E.S. SHIN	J.H.KANG	H.O.SONG	SCALE	1/1	PROJECT NO.	20120871TKE001	
2012.06.30	2012.06.30	2012.06.30	SIZE	A2	CAD NO	-	SHEET
HYUNDAI HEAVY INDUSTRIES CO., LTD.					REF. NO.	-	2/2
					DWG. NO.	TL2363 - A12	REV. 2

EXHIBIT C

Solicitation: RFP 1100 DTB1012REBID

Vendor Bid Acknowledgement

BIDDER INFORMATION	
Company name:	
Email Address:	
Printed Name:	
Signature of Authorized Representative:	

BIDDER ACKNOWLEDGEMENT: PLEASE CHECK ALL THAT APPLY		
☐	Full acceptance of City of Austin Terms & Conditions in Accordance with the 0100, 0200, 0300, and 0400 in Solicitation documents.	
☐	Full compliance with Austin Energy Specification.	
☐	5-year warranty	
☐	Unit delivery between July 1, 2021 and August 31, 2021	
☐	Delivery, installation and testing in accordance with Solicitation documents.	
☐	Evidence of compliance of at least 5 years of experience in the production of 345Y/138Y-13.2Δ kV, 672 MVA auto transformers for the United States electric utility market.	
☐	Evidence of compliance that the unit offered under this specification has been in commercial service in an electric utility in the United States for a minimum of five (5) years in the configuration being offered	
☐	The unit price listed on this Bid Sheet is the total price for one (1) complete transformer in accordance with ALL requirements of the Solicitation	
☐		
☐		