



) &DWDORJXH

2QVKRUH 3RZHU 6XSSO\ 6\VWHP

:LWK WKH GHYHORSEHQW IRF KQRSE XL OIQK MSSL QJHMGK/HRQ XPEHU
ODUJH WRQQDJH VKLS WDKSLG DQF DQGVWUKH SRZH URIVXSQR LQVWH
RI VKLS JHQHUDWRWV FDXOL QDQWKHIH WFWL YHDQJH HVGXFOH DLU DQG
SROOXWLRQ FDXVHG E\ WKH FRPEXVWLPRLQVLRQ HSWR WCK HDQD FDFM
WKH XVH RI RQVKRUH SRZHU VXSSO\LF XDUWRQDW WDIHQIX WXBRIUH
WUHQGV

&RPSRVLWLRQ RI 2QVKRUH 3RZHU 6XSSO\ 6\VWHP

7KH RQVKRUH SRZHU VXSSO\SRWHVW HFWKURQVSDUWWDWKDEOH
IUHTXHQF\ SRZHU VXSSO\KLS\WVRHFKRUHWHPQHQGVWRQ WKLSERDU
SRZHU UHFHLYLQJ V\VWHP DV VKRZQ RIQ+LJXUROWDKH \$QFKRW
3RZHU 6XSSO\ 6\VWHP



)LJXUH \$UFKLWHFWXUDJH RI QMLKRU YR3R ZHPU 6XSSO\ 6\VW

Onshore variable frequency power supply system ,W LV PDLQO\ FRPSRVHG RI KLJK
YDULDEOH IUHTXHQF\ SRZHU WRSO\SDSRQ UFRQJMLQJ FDEOH

Ship-to-shore connection system ,W LV FRPSRVHG RI SRORSDXODQJQRQFH
HWF

Shipboard power receiving system: ,W LV FRPSRVHG RI VKLSERDUG WUDQVIR
SRZHU UHFHLYLQJ FDSRUHG WKWSEHQVFRQDHEWLQW DDEOH H



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0DLQ)XQFWLRQV

7KH RQVKRUH SRZHU LVXSSDU DWVHW HPRQLSWRULHQFW LFRQWRUHWUHL
ELOOLQJ DQG HTXLSFDQWPHHQMDXWHQWQWYK RROWDJH RQVKRU
SRZHU FRQQHFWLRQ WKH YROWDSHUWIDBQXHQGH SRZHU JU

3RZHU FRQY&RQYRQW WKH YROWDSHUWIDBQXHQGH SRZHU JU
WKH YROWDJHUHTXHTXHQE\ VKLS

9ROWDJH 9	)UHTXHQF\ +]

7DEOH 9ROWDJH R XWHSTXMQH\ RQVKRUHQYDSRDEOHVXS\$D\
V\VWHP

5HJDUGLQJ WKH KHUXROWDQHS IMHTXHQFS UHTQRLWHDGO\ N9
+] +]

6KLS &RQQHFWLRQ 0HWKRG

High-voltage ship connection: 7KH QXPEHU RI FDBOMKHWFRQHFWLRQ LV V
DQG LW LV VXLWDEOH IRU ODUJH FDSDFLW\

Low-voltage ship connection 7KH QXPEHU RI ODBDBHWM FRQQHFWLRQ
FRPSOH\ DQG HWRUWVXLOWDEDSDFLW\

2QVKRUH SRZHU VXSSO\SRZHUFRWKRSDJH RUJ&RYZYROWD
XVXDOO\ WKH ZKXZGUX&HROORZHG

:KHQ SRZHU FDSDFLW\ UHTXLUHG LV OSRZHWVMDX\$SON9\$
FRXOG EH XVHG

:KHQ SRZHU FDSDFLW\ UHTXLUHG LV EHWKHYRQWDN9\$ DQO
SRZHU VXSSO\ LV VXJJHVWHG

:KHQ SRZHU FDSDFLW\ UHTXLUHG LV JUWDDMH\$SRVHKDQ
VXSSO\ VKRXOG EH XVHG

:KHQ WKH ORZ YROWDJH SRZHU VXSSO\ FRWKRSDJH WRDGR\$MH
FRQQHFWLRQ FDEOKH\LVXOWPHJRI DQ&DDEH HZKHQO ZLVOO RFFX
D ORW RI VSDFH)RU WKH VKLS RI VBDWB SURQQLD\$H WKM EDB
DQG FDEOH UHHO E\ ODQG VLGH

:KHQ WKH KLJK YROWDJH SRZHUWKSDJH DQ&FDEOH UHHO ZLOO
EH XVXDOO\ VXS\$O\HGHDFRUGLQJ SRDVKHLEQW\$UQDQWQ\$QD
ZLOO HVWDEOLVK\SRHQSRZHUWKSDJH\$S&FN IURQW

6KRUH WR VKLS 3RZHU&RQSDJHWRQZG WKRXW VKLS\V SRZHU
&RQQHFWLRQ ZLWK VKLS\V SRZHU UXQQLQJ

Connection without ship's power running: :KHQ WKH VKLS HQWHUV WKH SRUW



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DOO WKH HHTXLSVPHIQVD RQQV KHWVRLS W QHH UDVSR U JWHK HQ FRQQHF
WKH RQVKRUH SRZH D V X S X O I Q R Q G W L F D D K L T X V S H P O H Q W U W U H D
WKH VZLWFKLQJ I J R P H W B W R M K M S R V W K H S S Q V K R U H Q S R I Z H U W V I X S
O H D Y H V S R U W L W H V K B Q O U G V E H T U R I S Q B D W

Connection with ship's power running: ,W LV DOVR FDOOHG VIQFKURQLJDW
PRGH LQ ZKLFK W H C H V K L X S L B D H Q W U V Q R V U Q B W B S I H H F D W H I G R Q D Q G
K D V V L J Q L I L F D Q W L P S Q H W W D Q W R H U W K W Q L W B B M K K S S P H Q W
& R Q Q H F W L R Q Z L W K V K L S I V S R Z H U U X Q V K L Q U H P S R Z H U V V W K W H W U
D Q G L W S U R Y L G H V W K H T X L F N S U R W R E W R I R Q Q W R R I X D I S B D H W
V I V W H P

0 H W H U L Q J D Q V P H L D V V Q W K H U H T X L S H P H I Q W L R Q I P K J W H U L Q J D Q G
R I W K H S R U W H O H F W U L F H Q H U J I \

5 H D O W L P H O R V Q L Z L R O L Q R Q L W I R U H D O D O W W K H B B D B R W H S R Z H U V
V I V W H P \$ O O W K H D Q H D D X O W H L Q D R W D D W B R Q G E Q E C H P R Q
, Q W H J U D W H G \$ Q B Q W K R O I X Q F W L R Q V R I W K H V I V W H P D U H F R
G H G L F D W H G F R Q W U R O V I V W H P D Q G W K W R X X I K W X K H W B E S D Q H
E \ R S W L F D O I L E H U W B L D D Q V K H Q G X H V B Q L Y D U F D Q I O B I X I W H H T X H Q
S R Z H U V X S S O \ H T X L S P H Q W



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3URGXF 2YHUYLHZ

2QVKRUH 9DULDEOH)UHTXHQF\ 3RZHU 6XSS

%DVHG RQ LWV RZQ PDWXUH DQG UHOLXDEOH WILFKROWDJH
'RQJIDQJ (OHFWURQLVVLQJHS/WGGHQWOPDQHYDWRSHBGDQGH KLJ
YROWDJH RQVKRUH YDULDEOH IUHTXHQFRUSRZHU RQVSKRUHVSRZH
VXSSO\ VVWHP DQGHGDDQHRQWDEROLW SRZHUOLXS\ SURGX

7KH RQVKRUH YDULDEOH VXSSOHQVSRZ FRQYHUW WKH



') & D W D O R J X H

& R P S R Q H Q W) X Q F W L R Q



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&RPPXQLFDWLRQ	56 (WKHUQHW	
3URWHFWLRQ)XQFWLRQV	\$XWRPDWLF FXUUHQW OLPLWLQJ RY PRWRU RYHUORDGJRYHUQGHUYROW LQVWDQWDQHRXV SRZHU IDLOXUH L SKDVH ORVV FRROLQJ IDQ IDLOXUH IDXOW EISDVV SURWHFWLRQ WUDQ RXWSXW JURXQGLQJRXWSXWFRQGD VKRUW FLUFXLW	
\$ODUP)XQFWLRQV	,QSXW DQG RXWSXW RYHUORDG F RYHUKHDWLQJ ORLW SXWSXW VLQJ SKDVH JURXQGLQJRXWSXWROWDJH D FXUUHQW XQEDODQFH LQSXW GLVFRQQHFWLRQWFKRRWUDQZIRUPHU RYHUKHDWLQJ FRROLQJ IDQ IDLOXUH	



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FDQ EH UHDOLJHG

'LVSOD\ IXQDQLQVS,WD\ WKH IUHTXHQFWKYRHOWSKDVHF XQED OD
DFWLYH SRZHU UHDFWLYH SRZHU SRZHUWIDHVRXWSXW SRZH
VXSSO\ DQG GLVSDQ\PHDVWUWHQW IRIQHDFWLDQGSREBFWLYH
SRZHU HQHUJ\

3KDVH VHTXHQFH GHXWHFWHLQW DQB SBZHUVIRKXHSQFWH SKDDV
DXWRPDWLF DQGMPXDPHQW PRGHV

+DUGZLUHG LQWHUIDFMD&WPPDQBS RQFVHWWBSG HPHUJH
2SHUDWLRQDO SWZMXWHDGQDOXQQWQJ IDWQWSHVXWGRZQ
7KH SRZHU VXSSO\ TXZLOLKWUHFBSQW VWDQGDUGV

,W KDV SURWHFWKRDVIXQFWLDQDQFKXHQW FLUFXLW RYHUC
RXWSXW XQGHUYROWDWDJHLQBXWUXQGMDYIRQSYVHUKHDXHLQF\
UDQJH RYHUFXUUHQWHSKDLRHQORXVLVSDRQSMRWVFWLREQRUXW



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2QVKRUH 3RZHU 6XSSO\ 6ROXWLRQ

6ROXWLRQ &DWHJRULHV

9DULDEOH)UHTXHQF\ 6ROXWLRQ

High voltage variable frequency solution: ,W LV VXLWDEOH IRU VKLSV ZLWK ODUJ

Low voltage variable frequency solution: ,W LV VXLWDEOH IRU KRPPDLOS FDSDFLW\

*ULG)UHTXHQF\ 6ROXWLRQ

High voltage grid frequency solution: ,W LV VXLWDEOH IRU DUKLS FDSDFLW\

Low voltage grid frequency solution: ,W LV VXLWDEOH IRU KRPPDLOS FDSDFLW\

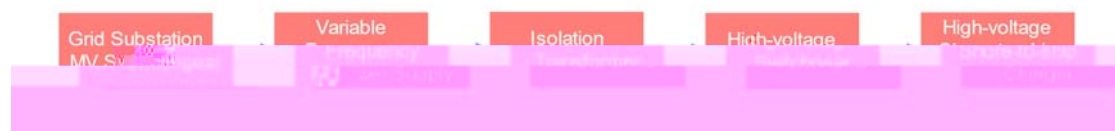
6KLS &RQQHFWLRQ 0HWKRG

High-voltage ship connection: 7KHUH LV D VWHS GRZQ WUDQVIRUPHU RQ VKLS FDEOHV WKH FRQQHFWLRQ EHWWHU ZSHZHUW FKLSHUVDQG SDK 7KLV VROXWLRQ LV VXLWDEOH IRU WKH FDSDFLW\

Low-voltage ship connection: 7KHUH LV QR VWHS GRZQ WUDQVIRUPHU RQ VKLS FDEOHV WKH FRQQHFWLRQ EHWWHU ZSHZHUW FKLSHUVDQG SDK 7KLV VROXWLRQ LV VXLWDEOH IRU WKH FDSDFLW\

%DVLF 6ROXWLRQV

+LJK 9ROWDJH 6KLS &RQQHFWLRQ DQG HIQFK\ 3ROWDJH 9DULDEOH 6XSSO\ 6ROXWLRQ ,W LV VXLWDEOH IRU WKH FDSDFLW\ ZLWKS GRZQWUDQVIRUPHU RQ





') &DWDORJXH

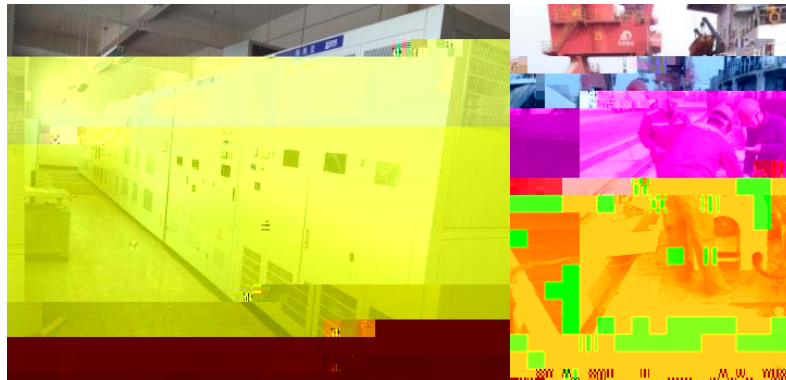
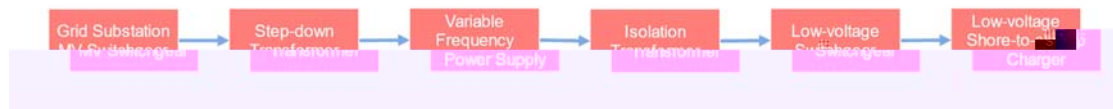
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,W LV VXLWDEOH OBUJMKFDSDESZLWQCSGRZQHWLWDDQVIRUPHU RQ

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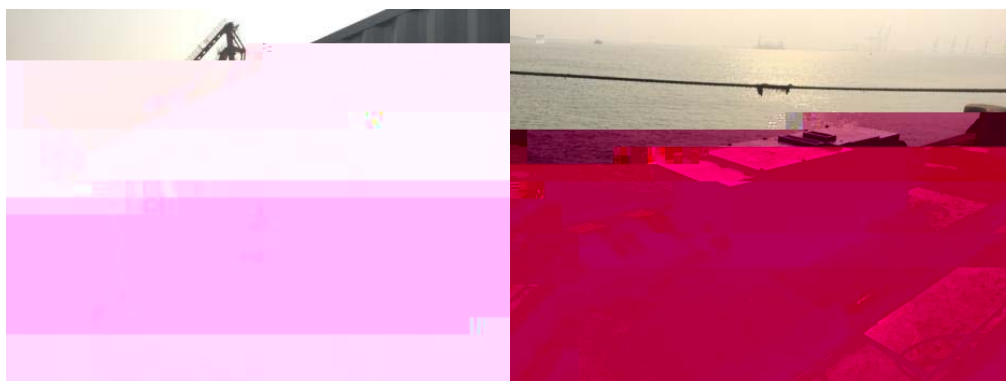


') & D W D O R J X H

/ R Z 9 R O W D J H 6 K L S & R Q Q H F W L R Q D Q G / R Z F Y R Q W H D J H 9 D U L D
 6 X S S O \ 6 R O X W L R Q
 , W L V V X L W D E O H M P U O W K H F V S K D S L W W H W R Q V L Q R S H W S R I Z H U V X S S O
 F R P H V I U R P W K H V X E H W D Q V L R Q H 9 H V L V D Q R I R W F I S U G R Q Q V W L S



, W L V V X L W D E O H M P U O W K H F V S K D S L W W H W R Q V L Q R S H W S R I Z H U V X S S O
 F R P H V I U R P W K H V X E H W D Q V L R Q H 9 H V L V D Q R I R W F I S U G R Q Q V W L S





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‡@pSpW10ChP f V0VpK 0 0 w'V8'M 8 V m !ò V"• C



') &DWDORJXH

5HIHUUHQFHV

2QVKRUH 3RZHU 5HIHUUHQFHV

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:HLKDL 3RU	*09 7) +96&	*)	09\$ 2636



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5R 3DVVHQJHU 7HUPLQDO			ZLWK	6&
/DLJKRX 3RJ*09 7) /96&	*)	09\$	2636 ZLWK	6&
1RWH09 *ULG 09 7) 7UDQVIRUPHU 6'7) 6W,03) GRZQ 7UD ,VRODWLRQ 7UDQVIRUPHU 7UDQVIRUPHU 2332H06XSSO\ +96& +LJK YROWDJH 6KRUH WR VKLS &KDUJHU WR/96&LS/RZ Y &KDUJHU 6& 6KRUH WR VKLS &KDUJHU *9) LG9DULDEOH) UHTXH				

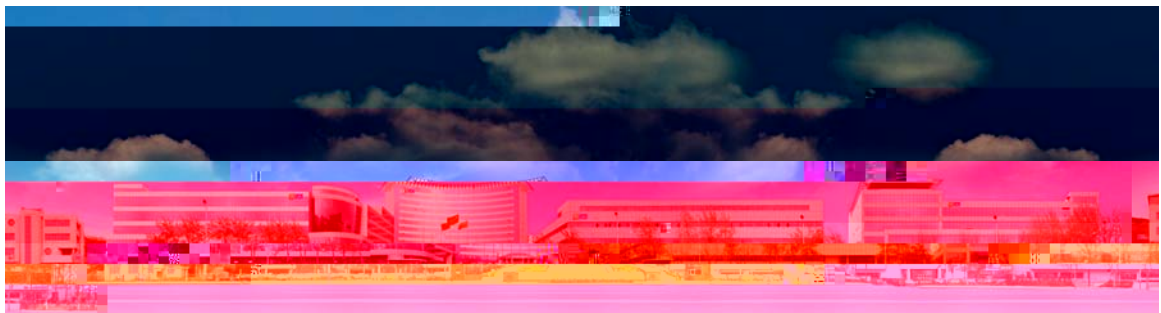
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%RKDL <DQWDL	) +LJK YRO' 09\$H		%RKDL 3HDUO %RKDL *UHHQ 3HDUO %RKDL &U\ VWDO 3HUDO %RKDL 'LDPRQG 3HDUO %RKDL \$JDWH 3HDUO 6KHQJVKHQJ	
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%RKDL /RQJNRX	) +LJK YRO' 09\$H		%RKDL +HQJGD %RKDL +HQJWRQJ	QJ

'RQJIDQJ (OHFWURQLFV ,QWHUQDWLRQDO (QJLQHULQJ
'RQJIDQJ (OHFWURQLFV &R /WG
\$GGUHV 1R -LFKDDJ 5RDQGGRQWURQDFH 35 &KL
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(1*,1((5,1* &2 /7' \$// 5,*+76 5(6(59('