

ICS 29.200
CCS K 46



**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 3859.2-2013

Replacing GB/T 3859.2-1993

**Semiconductor converters -- General requirements and line
commutated converters -- Part 1-2: Application guide**

半导体变流器 通用要求和电网换相变流器 第1-2部分：应用导则

(English Translation)

Issued on: July 19, 2013

Implemented on: December 2, 2013

**Issued by: General Administration of Quality Supervision, Inspection and
Quarantine of the People's Republic of China, Standardization
Administration of the People's Republic of China**

Table of Contents

Preface	
1 Scope	
2 Normative references	
3 Terms and definitions	
3.1 Terms related to converter failure	
3.2 Terms related to transient phenomena generated by converters	
3.3 Terms related to temperature	
3.4 Terms related to harmonics	
4 Performance of the converter and its system	
4.1 Application area	
4.1.1 Overview	
4.1.2 Variable current systems and equipment	
4.1.3 Power supply regulation (active power and passive power)	
4.2 Main technical parameters	
4.2.1 Main items that should be given	
4.2.2 Other information	
4.2.3 Abnormal operating conditions	
4.3 Converter transformer and reactor	
4.4 Calculation factor	
4.4.1 Overview	
4.4.2 Voltage ratio	
4.4.3 Grid-side current factor of the converter	
4.4.4 Current factor on the valve side of the converter	
4.4.5 Voltage adjustment value	
4.4.6 Magnetic circuit	
4.4.7 Power loss factor	
4.5 Parallel connection and series connection	
4.5.1 Parallel connection or series connection of valve devices	
4.5.2 Parallel or series connection of components and equipment units	
4.6 Power factor	
4.6.1 Overview	
4.6.2 The text symbols used to determine the fundamental power factor	

- 4.6.3 In rectifier operation and inverter operation, it is used to approximate the fundamental wave power factor $\cos\phi_{1N}$ and reactive power Q_{1LN} .
- 4.6.4 Calculation of fundamental wave power factor $\cos\phi_{11}$
- 4.6.5 Variable flow factor
- 4.7 DC voltage adjustment value
 - 4.7.1 Overview
 - 4.7.2 Inherent DC voltage adjustment value
 - 4.7.3 DC voltage adjustment value caused by AC system impedance
 - 4.7.4 Information that the supply and demand parties should exchange on the DC voltage adjustment value of the converter
- 4.8 Reliable operation in inverter state
- 4.9 AC voltage waveform
- 4.10 Circuit operating conditions that affect the voltage applied to the converter valve device
- 4.11 Overvoltage protection
- 4.12 Influence of environmental conditions on converter operation
- 5 Calculation of main parameters
 - 5.1 Actual calculation of operating parameters
 - 5.1.1 Overview
 - 5.1.2 Assumptions
 - 5.1.3 Preliminary calculation
 - 5.1.4 Calculation of operating conditions
 - 5.2 Voltage change of power supply system caused by converter load
 - 5.2.1 Fundamental voltage change
 - 5.2.2 Minimum R_{1SC} value required for voltage changes
 - 5.2.3 The ratio of the converter transformer
 - 5.2.4 Transformer rating
 - 5.3 Compensation of reactive power consumption of converter
 - 5.3.1 Average reactive power consumption
 - 5.3.2 Average reactive power to be compensated
 - 5.3.3 Voltage fluctuation for fixed reactive power compensation
 - 5.4 Supply voltage distortion
 - 5.4.1 Commutation gap
 - 5.4.2 Operation of multiple converters in the same power supply network
 - 5.5 Harmonics generated by converter operation on the grid side
 - 5.5.1 Root mean square value of grid-side current

- 5.5.2 Harmonics on the grid side (approximate method for 6-pulse converter)
- 5.5.3 Harmonic distortion and minimum R1SC requirements
- 5.5.4 Estimation of phase shift of harmonic current
- 5.5.5 Superposition of harmonic current
- 5.5.6 Peak and average harmonic spectrum
- 5.5.7 Phase shift of transformer
- 5.5.8 Sequence triggering of two 6-pulse converters
- 5.6 Power factor compensation and harmonic distortion
 - 5.6.1 General
 - 5.6.2 Resonant frequency
 - 5.6.3 Direct parallel capacitor compensation device
 - 5.6.4 Estimation of resonance frequency
 - 5.6.5 Detuning reactor
 - 5.6.6 Ripple control frequency (carrier frequency)
- 5.7 Harmonic content of DC voltage
- 5.8 Other considerations
 - 5.8.1 Random control angle
 - 5.8.2 Instability of sub-harmonics
 - 5.8.3 Harmonic filter
 - 5.8.4 Estimation of cable capacity
- 5.9 Calculated current value when the DC side is short-circuited
- 5.10 Selection of immunity level
 - 5.10.1 Overview
 - 5.10.2 Selection of immunity level
- 6 Test requirements
 - 6.1 Estimation of power loss from short circuit test
 - 6.1.1 Single phase connection
 - 6.1.2 Multi-phase double shot connection
 - 6.1.3 Multiphase single shot connection
 - 6.2 Steps to estimate power loss using the short-circuit method
 - 6.3 Test method
 - 6.3.1 Method A1
 - 6.3.2 Method B
 - 6.3.3 Method C
 - 6.3.4 Method D

6.3.5 Method E

6.3.6 Method A2

7 Calculation of the load current and junction temperature of the converter

7.1 Description of peak load rated current

7.2 Characters related to effective junction temperature

7.3 Determine the ability to withstand peak loads by calculating the effective junction temperature

7.3.1 Overview

7.3.2 Approximate power pulse waveform applied to a semiconductor device

7.3.3 Superposition method for temperature calculation

7.3.4 Calculation of continuous load effective junction temperature

7.3.5 Periodic load effective junction temperature calculation

7.3.6 Calculation of effective junction temperature for several typical applications

8 Converter operation

8.1 Stability

8.2 Static characteristics

8.3 Dynamic characteristics of the control system

8.4 Operation mode of single converter and double converter

8.4.1 Single converter connection

8.4.2 Restrictions during dual converter connection and rectification and inverter operation

8.5 Transition current

8.6 Suppression of DC Circulating Current in Dual Converter Connection

8.6.1 Overview

8.6.2 Limit trigger delay angle

8.6.3 Control circulation

8.6.4 Blocking trigger pulse

8.7 Working Principle of Inverter for DC Motor Control

8.7.1 Overview

8.7.2 Motor magnetic field reversal

8.7.3 Use the reverse switch to reverse the motor armature

8.7.4 Double converter connection of motor armature

9 Converter fault handling

9.1 Overview

9.2 Fault detection

9.3 Fault current protection