Chip Cutters [Semiconductor manufacturing equipment]

Features of chip cutters

Chip cutters in semiconductor manufacturing equipment cut silicon wafer into individual chips.
Inverters drive high speed motors with diamond cutters.

Merits of inverter drives

Chip cutters with inverters have the following merits:

- SEMI F47 compliance
VFAS1 and VFPS1 comply with SEMI F47.

- Variable speed control
Inverters can control high speed motors that are like spindles.

- 500Hz operation with standard inverters
The standard VF-S15 and VF-AS1 design allow for 500Hz operation.
(120x500Hz/2poles = 30000min^{-1})

Notices regarding the use of inverter drives

- **Stalling caused by short acceleration time**
Usually, the setting of a short acceleration time causes an OC1 trip (over current while accelerating) or an OL1 trip (overload in inverters).
However, in case of short time acceleration in high speed motors, it is likely that the motors might stall
Therefore, please set a long acceleration time to use a high speed motor.

Stalling:
When the acceleration torque is larger than the breakdown torque, motor slips are increasing beyond their slip rating, and motors cannot continue to rotate.

- **Short circuit detection at start-up**
Impedance of high speed motors is smaller than that of standard motors.
Therefore, the protective function of output short circuit detection at start-up sometimes causes malfunctions.
In this case, please set F613 (short circuit detection at start-up).

- **Electromagnetic noise**
The inverter is generating "electromagnetic noise".
If there are some high accuracy sensors or other sensitive equipment near the inverter drive, the inverter's noise may cause some trouble or a malfunction.
Electromagnetic noise can be avoided by installing an external noise filter or using a different wiring method.

- **Harmonics**
The inverter is generating "harmonics".
These harmonics sometimes cause a malfunction in other control equipment that is connected to the same power source.
Harmonics can be avoided by installing an external "reactor".

To decrease "harmonics", we recommend to install DC reactors in all our inverter models. (NOTE: 100V input models require AC reactors.)

Selection

When using high speed motors, the inverter capacity should be larger than the motor capacity.

When choosing inverters for chip cutters, please pay attention to the following key points:

- Maximum frequency
- Acceleration time
- Deceleration time
- Vibration

- Maximum frequency
In standard models of VF-S15 and VF-AS1, the maximum frequency is 500Hz (30000min^{-1}).

- Acceleration/deceleration time
When setting of acceleration/deceleration times, please pay attention to the following potential problems:.
- In case of a short acceleration time: Stall or OC1 trip may occur.
- In case of a short deceleration time: OC2 trip or OP2 trip may occur.
To avoid these inverter trips, please calculate acceleration/deceleration time as follows:

Acceleration time $t_a = \frac{(J_M + J_L) \times \Delta N}{9.56 \times (\alpha \times T_M - T_L)}$ (second)

J_M : Inertia of motor (kg·m^2)
J_L : Inertia of load (converted into value at motor shaft) (kg·m^2)
ΔN : Difference of speed between before and after acceleration and deceleration (min^{-1})
T_L : Load torque (N·m)
T_M : Rated torque of motor (N·m)
α : 1.2 to 1.5 for V/f constant control, 1.5 to 2.0 for vector control

Deceleration time $t_b = \frac{(J_M + J_L) \times \Delta N}{9.56 \times (\beta \times T_M + T_L)}$ (second)

J_M : Inertia of motor (kg·m^2)
J_L : Inertia of load (converted into value at motor shaft) (kg·m^2)
ΔN : Difference of speed between before and after acceleration and deceleration (min^{-1})
T_L : Load torque (N·m)
T_M : Rated torque of motor (N·m)
β : In case of a braking resistor not used: 0.1 to 0.3
In case of a standard-optional braking resistor used: 0.8
In case of a braking resistor with a minimum allowable resistance used: 1.0 to 1.5

- Vibration

The output current of inverters don't form a sine waves. This can sometimes cause motor vibrations.
In high speed operation, please confirm the following:
- Vibrations are within the specified allowance.
- Avoid the resonance point of the machine system

Application samples

Chip cutters usually use the following operating methods:

- RUN and STOP operations by remote control
- Frequency setting by operation panel (fixed frequency setting)
- Output signal when full acceleration has been reached.
- Emergency stop signal input

Setting table for inverters (VF-AS1)

The following table shows parameter settings for VF-AS1 and a high speed motor (360Hz: 21600min^{-1}) manufactured by TIPM.
TIPM: Toshiba Industrial Products Manufacturing Corporation

Features:
S3 terminal: Emergency stop signal input
OUT2 terminal: Output signal when full acceleration has been reached.
Frequency setting by operation panel: Press up/down key/output frequency is shown on LED.

Title	Function	Setting range	Recommended setting
CMOd	Command mode selection	0 to 1	0
FM	Frequency setting mode selection 1	0 to 6	4
uL	Base frequency 1	25 to 500Hz	360
FH	Maximum frequency	30 to 500Hz	360
UL	Upper limit frequency	0.0 to Maximum frequency	360
F101	Full acceleration setting frequency	0.0 to Upper limit frequency	360
F116	Input terminal function selection 6 (S3)	0 to 135	20
F131	Output terminal function selection 2 (OUT2)	0 to 255	8
F613	Selection of short circuit detection at starting	0 to 5	2