Compact Speed Monitoring and Overspeed Protection System
FT 3000

Features

- Designed for 2 from 3 overspeed protection
- Configuration via PC
- Standard unit includes
  - Speed measurement
  - Speed relays
  - Sensor monitoring
  - Direction discriminator
  - Test frequency generator
  - Supply monitoring
  - Isolated control lines
- Modular system expansion to include
  - Isolated analog outputs with independent ranges
  - Intrinsically safe input card (Ex)
  - 2 from 3 selection
  - Redundant power supply
  - Display in the rack
- Configuration stored in EEPROM
- Period measurement principle
- Input directly in machine units eg speed, % etc.
- Module for remote diagnostics
Application

The Jaquet FT 3000 system has been specially developed for high integrity overspeed protection of gas or steam turbines and other similar primary drives.

The FT 3000 has been developed as a true 3 channel system that permits machine protection with 2 from 3 voting control at a favourable price. It provides a cost effective solution to monitoring safety critical installations.

Maximum availability and high system integrity is achieved through complete redundancy of all functions, along with continuous self checking and test possibilities at each stage in the channel.

The clear and open system architecture, using a bus interface, enables the FT 3000 to be used with a master control system so that it provides independent monitoring and machine protection, whilst being part of an integrated system.

The system conforms to American Petroleum Institute (API) regulations together with all appropriate European (EN) standards.
**Operation**

Each channel in an installation is built up separately using Compact Modules. A Compact Module comprises of a FTFU 3024 motherboard plus optional plug in expansion cards (frequency to current converter FTW 3013, relay module FTV 3090). Thanks to large scale hardware integration the system has a minimal space requirement.

The FT 3000 monitors 4 set points per channel. The installation can be configured for 2 from 3 voting of the set points. The alarm signals can also be fed to an external system for 2 from 3 voting control. Since the motherboard can be equipped with intrinsically safe input circuits for connection to numerous speed or eddy current sensors, there are no external restrictions on the number of applications for this system.

The system provides independently scalable analog outputs and carries out a variety of mathematical functions, such as maximum values (also stored) and the calculation of average values together with acceleration.

The FT 3000 permanently checks its system integrity. A test generator integrated on the motherboard enables live testing of each entire channel. The sensor watchdog permanently monitors the sensor for correct operation.
**Application examples**

**Example 1:**
FT 3000 without 2 from 3 logic, supply modules or analog card

Example 1 shows a basic FT 3000 configuration. 3 channels are each independently monitored by a FTFU 3024 motherboard. It is assumed that the customer already has a secure power supply and that the 2 from 3 logic for the alarm signals is executed in a higher level system. There is no speed proportional analog output but sensor monitoring, numerous test possibilities along with a communications interface to higher level systems are naturally included.

In contrast, example 2 shows an installation that has 3 analog signals per channel in addition to the user programmable limit values. Extensive mathematical functions are available to define these signals. With the addition of FTV 3090 modules, the set point signals are combined to provide 2 from 3 voting within the system.

To achieve redundancy in the power supply, 2 supply modules provide an uninterrupted supply to the operating modules. The communications module provides an interface to the outside world and is used for system programming, monitoring and diagnosis via a PC or higher level system.

**Example 2:**
FT 3000 with internal 2 from 3 logic, analog outputs and 2 supply modules
Programming

With the FT 3000, Jaquet has set new standards for the definition of operating and configuration parameters. Dedicated Windows software provides a clear system overview and easy programming of multiple values. Parameter sets can be processed and stored on or off-line and the software allows current system status to be continuously monitored.

For security reasons, 3 level password access is provided to crucial data.

The communications module provides a bi-directional interface for data and parameters. Used together with a modem, this allows remote diagnostics of data, alarms and configuration.

Functions and configurations can be printed out for archiving and subsequent system comparisons. These printouts can also form part of the commissioning and hand-over documentation, showing the system parameters defined.
Modul overview

FTFU 3024
Monitoring module (motherboard)

This card is used for monitoring a speed (function frequency relay and/or speed detector), the speed direction as well as the correct functioning of the connected speed sensor. For test purposes the instrument is equipped with an integral frequency generator. The monitoring module is a plug-in unit with a width of 4 rack units.

Period measurement principle

The frequency relay is microprocessor based and works according to the period measurement principle with subsequent computing of the reciprocal value (calculating principle). The sensor frequency is measured continuously.

The number of periods considered for one measurement depends on the minimum measuring time (= Fix Time) and the input frequency corresponding to the limit to be monitored.

Limits

After entering the machine factor $M = f/n$ with $f$ [Hz] = signal frequency of the sensor at a known machine speed and $n$ [RPM] = machine speed, the limit can be entered directly in RPM.

Alternatively, the number of poles of the pole wheel (= number of impulses per revolution) and the nominal speed (= 100%) can be entered. The limits are then entered in % of the nominal value.

The switch on point (= upper limit = limit high) and the switch off point (= lower limit = limit low) can be entered separately for each alarm so that almost any hysteresis can be realised.

The measuring result is used for:

- monitoring of 4 limit values
- controlling 3 independently configurable analog outputs
as well as for the processing and display of:

- measured value
- maximum value
- acceleration

Further input frequencies from 1 or 2 redundant speed sensors can be measured and processed in the following way:

- Mean value of 2 or 3 measuring channels
- Maximum value of 2 or 3 measuring channels
- Selection of 2 out of 3 with error message (dynamic sensor monitoring)

On request three of the four limit values can be monitored with a min. measuring time of 1 ms by three speed detectors (realised in hardware).

Parameter input

The input of all parameters is via an RS485 interface. A PC solution with configuration program is available from JAQUET. The input parameters are entered according to the matrix principle.

The parameters are stored independent of the power supply by an EEPROM.

Technical Data Frequency inputs

Frequency input 1

Floating, dielectric proof 500 V, 50 Hz against electronic and protective earth, i.e. against front panel and module.

A selection of plug-in modules are available to cater for the various requirements of input sensitivity and supply of speed sensors. The variants are marked with an additional number in the type designation on the label (see overview of the technical data).

For test purposes the input trigger level is adjustable at the front panel, together with the permissible min./max. and effective sensor current.

Frequency input 2 and 3

dc-coupled, with negative pole of power supply as reference potential.
$U_{low}: 0…+3$ V resp. open; $U_{high}: +10…+33$ V
$I_{source} = 4$ mA;

frequency measurement with redundant speed sensors.

Binary inputs

The six binary inputs provide configurable test and monitoring functions, e.g.

- switching over (shift) of limit values
- input and selection of two internally generated test frequencies
- resetting the system alarm and limit outputs

To store a new configuration the reset input has to be activated for a short-time after switching on the mains supply and also after any occurrence of an error message due to the actuation of the start-up bridging, of the sensor monitor or the microprocessor watchdog, before the collective alarm and the binary outputs again correspond to the actual measured values.

Binary inputs 1 to 4:

Floating, dielectric proof 500 V, 50 Hz against each other and against electronic and protective earth, i.e. against front panel and module.

$U_{low}: 0…+5$ V bzw. open; $U_{high}: +10…+33$ V;
$I_{source} = 4$ mA max.

Binary inputs 5 and 6:

With the negative pole of the rack supply of 24V as reference potential

$U_{low}: 0…+1$ V, $I_{sink} = 1$ mA max.
$U_{high}: +3.5…+33$ V resp. open
**Limits**

You can define three lots ("A", "B", "C") of each 4 limits with the following parameters:

- lower switching point (LIMIT low)
- upper switching point (LIMIT high)
- Function (LIMIT mode) = normal or inverse
- Status (LIMIT status) = on or off

When exceeding the upper limit at "normal" and "on" the corresponding output is activated resp. the assigned relay is energized.

When falling below the lower limit the output is inactive resp. the assigned relay is de-energized.

At "inverse" and "on" the status above described are inverted.

At "off" the corresponding output is always inactive resp. the relay de-energized.

The status for limit exceeded/fallen below are signalled by four red/green LED-pairs. The assignment of the colour to the relevant status of each limit is done in a user configuration.

**System monitoring**

A failure is signalled in case of the following events:

- Microprocessor self-test error
- Run-out of the Watchdog-Timer
- Supply voltage failure
- Interruption of power supply fuse
- Mains failure

A green LED is on as long as there are no failures.

**Two frequency outputs**

**Frequency output 1**

Impulse output, with negative pole at reference potential

- Push-pull circuit: Impulse amplitude +10 Vp output resistance 100 Ω
- Output current: 50 mA continuous 100 mA temporary (10% duty cycle)

**Frequency output 2**

Floating impulse output

Dielectric proof 500 V, 50 Hz against electronic and protective earth, i.e. against front panel and module.

- Push-pull circuit: Impulse amplitude 15 Vpp Output resistance 100 Ω
- Output current: 50mA continuous 100 mA temporary (10% duty cycle)

**Relay outputs**

Each of the three relays in the module can be assigned to any limit or monitoring function.

At collective alarm (due to the system monitoring and/or the sensor monitoring) the relays are de-energized.

The maximum reaction time is equal to double the selected minimum measuring time (Fix Time) +1 period of the input frequency +2.5 ms computing time.

For the Fix Time the following values can be selected: 5/10/20/50/100/200/500 ms /1/2/5 s

With a Fix Time of 5ms and a switching frequency >2000 Hz, the reaction time of the relay outputs is max. 14.5 ms and typ. 12.0 ms for de-energizing respectively max. 21.0 ms and typ. 18.5 ms for energizing.
Modul overview

**FTW 3013**
Frequency-current converter (supplementary module)

This instrument is used together with the monitoring module FTFU 3024 for measurement of a frequency resp. a frequency proportional speed. The converter is mounted as supplementary module on the module FTFU 3024 and represents thus a plug-in module with a total width of 8 rack units.

**Analog outputs**

The three D/A-Converters in the FTW 3013 permit the display of three frequency ranges or of mean values, maximum values or 2 of 3 majority values on three current output ranges, independent of each other.

**Measurement**

The number of periods considered for one measurement depends on the selected measuring time (= Fix Time) and the input frequency.

The initial and end values of each measuring range can be entered as speed value in RPM after input of the machine factor M=1/n with f [Hz] = signal frequency of the sensor at a known machine speed and n [RPM] = machine speed.

Alternatively, the number of poles of the pole wheel (= number of impulses per revolution) and the nominal speed (= 100%) can be entered. The input of the initial and end value of the measuring range is then directly entered in percent of the nominal value.

For each measuring range the initial and end value as well as the corresponding current output can be entered separately.

**Parameter input**

The input of all parameters is made at the FTFU 3024 with the RS485 interface accessible at the rear and according to the matrix principle.

The parameters are stored independent of the power supply by an EEPROM.

**Technical Data**

**FTW 3013**

**Setting time**

(1% difference to the final value.) The maximum setting time is equal to double the selected minimum measuring time (Fix Time) + 1 period of the input frequency + 2.5 ms computing time + 5.0 ms transient time.

For the Fix Time the following values can be selected:

5/10/20/50/100/200/500 ms /1/2/5 s

With a Fix Time of 5ms the setting time of the analog outputs for circuit frequencies > 2000 Hz is max. 18 ms and typical 16.5 ms.

The current at the moment of switching on is equal to the initial value of the range.

The three current outputs show 0 mA in case of a collective alarm (due to the system monitoring and/or the sensor monitoring).

**FTV 3090 Relay module**
(supplementary module)

This instrument is used for monitoring a frequency resp. a frequency proportional speed together with the monitoring module FTFU 3024. With four separate relays it permits the simultaneous switching of several galvanically isolated loads.

The relay module FTV 3090 is fixed as a supplementary module on the monitoring module and represents thus a plug-in module with a total width of 8 rack units.

It can alternatively be fixed with the monitoring module and the supplementary module FTW 3013 and represents thus a plug-in module with a total width of 12 rack units.

**Functions**

Each of the 4 relays of the module may perform the same functions as the 3 relays of the monitoring module FTFU 3024.

**Parameter input**

All additional parameters are entered with a RS485 interface accessible at the rear of the monitoring module and according to the matrix principle.

The parameters are stored independent of the power supply by an EEPROM.
FTK 3072
Communication module
The communication module FTK 3072 is used for communications between the rackbus, i.e. RS485 interface accessible at the rear of the monitoring module FTFU 3024 (max. 31 modules) and a host computer, PC or a memory programmable controller.
All parameters for the modules are then entered through the master system.

FTZ 2061/3061
Power supply unit
Input voltage 115/230 V AC, -20%, +15%

FTZ 2062/3062
Power supply unit
Input voltage 24/48 V AC, -20%, +15%

FTZ 2064/3064
Power supply unit
Input voltage 14…70 V DC

FTZ 2065/3065
Power supply unit
Input voltage 88…372 V DC, 85…264 V AC

Common data for power supplies:
Input voltage: galvanic isolation, dielectric proof 2000 V, 50 Hz 1 min., against protective earth, i.e. front panel, module and output. Output voltage nominal: 24 V DC, 5% min. 18 V DC/2 A/36 W max. 33 V DC/1.3 A/43 W. With an output voltage of 18…33 V DC control LEDs are illuminated.

FTZ 2069
Mains filter
Without front panel, width 12 rack units. Necessary, if the plug-in modules are directly supplied with 24 V DC.

Input/Output of the Modules

<table>
<thead>
<tr>
<th>Chart 1: Input/output of the modules</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensor input</td>
</tr>
<tr>
<td>FTFU 3024</td>
</tr>
<tr>
<td>FTW 3013</td>
</tr>
<tr>
<td>FTV 3090</td>
</tr>
<tr>
<td>FTK 3072</td>
</tr>
<tr>
<td>FTU 2045/3045</td>
</tr>
<tr>
<td>FTU 2020/3020</td>
</tr>
</tbody>
</table>

*) Modules from FT 2000 which are compatible with FT 3000
### Technical data of modules

#### Chart 2: Technical data of modules

<table>
<thead>
<tr>
<th>FTU 3024</th>
<th>FTV 3090</th>
<th>FTV 3072</th>
<th>FTZ 306X</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rack mounting</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;Plug-in 19&quot; rack mounting modules, Europa card size&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height: 3 units = 132.5 mm, width: 4 units = 20.32 mm</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Height: 3 units = 132.5 mm, width: 12 units = 60.96 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height: 3 units = 132.5 mm, width: 20 units = 101.60 mm</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Precision</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.1% according to DIN/VDE 0410, referring to the corresponding limit value</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Resolution of the limit input</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 decades resp. 0.1%</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Temperature drift</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>max. 50 ppm/°K referring to the corresponding limit value</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Max. 150 ppm/°K</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Power supply</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18 ... 33 V DC, typ. 1.8 W/max. 3 W</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Voltage is stabilized on +5V with a regulator and if necessary galvanically separated through oscillation transformers.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Protection against mains volt. failure</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains voltage failure bridged up to 50 ms without malfunction</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ambient temperature</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0...+60 °C, +70 °C during max. 2 hours</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>over 60 °C without functioning liquid crystal display</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Storage temperature -20...+85 °C</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td><strong>Frequency range</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0.050 Hz...29.99 kHz</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lowest: 0...0.9990 Hz</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>highest: 0...29.99 kHz</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>The range may be passed as long and as high as you like (max. 50 kHz), without malfunction or damage of the instrument.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Frequency potential free, dielectric proof 500V, 50Hz against electronics and protective earth, i.e. against front panel and rack frame. Respond sensitivity and sensor supply depending on the used module.</strong></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTFU 3024-01: 50 mVeff/12 V Sensor supply, max. 25 mA/Ex i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTFU 3024-02: 50 mVeff/12 V Sensor supply, max. 50 mA/not Ex i</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FTFU 3024-03: programmable acc. to Standard API 670</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frequency input 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-coupled, negative pole of the power supply as reference potential</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( U_{\text{low}} ): 0...+1V, ( I_{\text{sink}} = 1 ) mA max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( U_{\text{high}} ): +3.5 V...+33 V resp. open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Frequency input 2 and 3</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-coupled, negative pole of the power supply as reference potential</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>( U_{\text{low}} ): 0...+1V, ( I_{\text{sink}} = 1 ) mA max</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( U_{\text{high}} ): +3.5 V...+33 V resp. open</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Binary input 1...4</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-coupled, potential free, dielectric proof 500 V, 50 Hz against electronics and protective earth, i.e. against front panel and rack frame. Active low: ( I_{\text{sink}} = 1 ) mA</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>high: ( U = +3.5 ) V...+33 V resp. open</td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Binary input 5 and 6</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>DC-coupled, negative pole of the power supply as reference potential</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>( U_{\text{low}} ): 0...+1V, ( I_{\text{sink}} = 1 ) mA max.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>( U_{\text{high}} ): +3.5 V...+33 V resp. open</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Technical data of modules

**Frequency output 1**

- Impulse output with negative pole of power supply as reference potential
- Push-pull circuit:
  - Amplitude +10 V; impedance 100 Ω
- Output current:
  - ±50 mA continuously admissible;
  - ±100 mA temporary (10% duty cycle)

**Frequency output 2**

- DC-coupled, potential free, dielectric proof 500 V, 50 Hz against electronics and protective earth, i.e. against front panel and rack frame.

**Other data according to frequency output 1**

**Relay outputs**

- Potential free change-over contacts, max. 250 V, 1 A, 50 W.
- At inductive load external spark suppression is necessary.
- A green LED signals relay energized.

**Relay outputs functions**

- Limit value 1, 2, 3 or 4
- Sensor monitoring
- Sensor AND Module monitoring logically combined
- Module monitoring
- Supply monitoring
- Supply AND Module monitoring logically combined
- Direction of rotation
- On/off

**Current output**

- 0…20 mA resp. 4…20 mA; selectable for rising or falling transfer function.
- Maximum load 500 Ω corresponding to a maximum of 10 V; maximum open-circuit voltage 20 V; potential free, dielectric proof 500 V, 50 Hz against each other and against electronics and protective earth and against front panel and rack frame.

**Resolution**

- 12 Bit corresponding to 1:4096
- Linearity error: max. 0.1%

**Electromagnetic compatibility (EMC)**

- Power supply circuit:
  - IEC 255-4 common mode: 2.5 kVs
  - IEC 255-4 series mode: 1.0 kVs
  - IEC 801-4 common mode: 2.0 kVs
- Input and output circuits:
  - IEC 255-4 common mode: 2,8 kVs
  - IEC 255-4 series mode: 1,0 kVs
  - IEC 801-4 common mode: 1,0 kVs

**Interface**

- Local Bus (Standard for all Modules FT 3000)
- Rack-Bus (interface RS485, with negative pole of dc power supply 18…33V as reference potential, dielectric proof 500V, 50Hz against protective earth, against front panel and rack frame.
- Men/machine via key buttons