TOYOTA SAS Guide

TOYOTA
INDUSTRIAL EQUIPMENT

TOYOTA SAS components

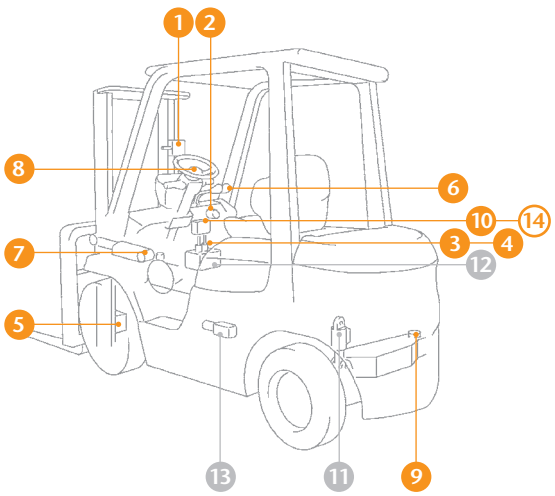
Toyota's SAS controller will calculate from the information of the sensors whether the forklift is in a potentially dangerous situation or not, and will accordingly activate the appropriate actuator(s) to improve safety, without impairing productivity.

10 Sensors	Drive Function	Mast Function	Steering Function	Role
1 • Fork Height Switch	●	●		Senses whether the mast is higher than approx. 2 m.
2 • Tilt Angle Sensor		●		Senses mast angle
3 • Front Tilt Limit Switch		●		Senses whether the operator tilts forwards
4 • Rear Tilt Limit Switch		●		Senses whether the operator tilts backwards
5 • Load Sensor	●	●		Measures load weight using hydraulic pressure
6 • Tilt Knob Switch		●		Senses whether the operator depresses the switch
7 • Vehicle Speed Sensor	●			Measures vehicle speed
8 • Steering Wheel Angle Sensor			●	Measures position of steering wheel
9 • Tyre Angle Sensor			●	Measures angle of rear steer wheels
10 • Yaw Rate Sensor	●			Measures truck lateral acceleration

3 Actuators				
11 • Swing Lock Cylinder	●			Locks the rear axle
12 • Hydraulic Oil Control Valve		●		Regulates oil flow to tilt cylinders
13 • Steering Sychroniser Solenoid			●	Regulates oil flow to steering cylinder in order to adjust the steering wheelknob position to the position of the rear steer wheel

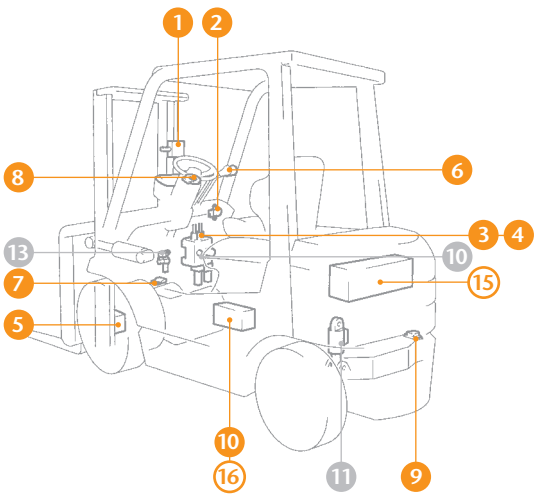
Engine Powered Forklift

On engine powered forklifts, there is a unique Toyota SAS processor (14).



Battery Powered Forklift

On battery forklifts, the Toyota SAS processor for the mast function is part of the main controller (CPU) (15). As for the drive and steering functions, the processor is part of the steering controller (SCPU) (16).



TOYOTA SAS Drive Function

A side tip-over happens when the position of the centre of gravity of the forklift moves sideways, out of the stability area of the forklift. Typically, this happens when a forklift is turning at high speeds, or changing directions.

4 Sensors

1 • Fork Height Switch

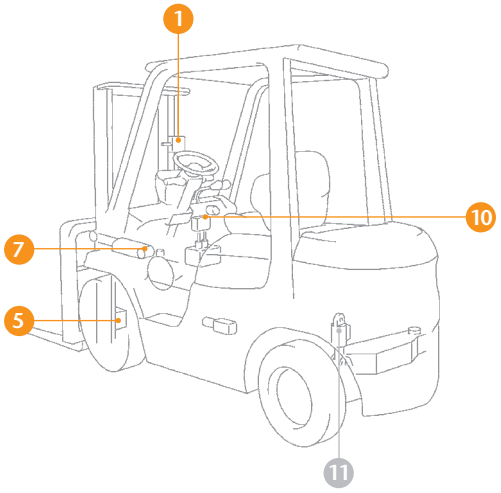
5 • Load Sensor

7 • Vehicle Speed Sensor

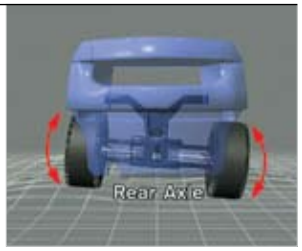
10 • Yaw Rate Sensor

1 Actuator

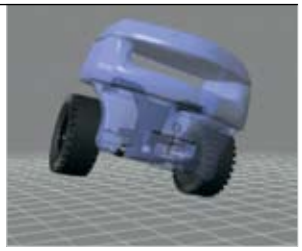
11 • Swing Lock Cylinder



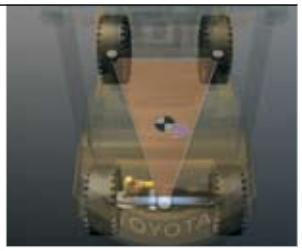
1. Pivoting Axle
The rear axle is free to pivot, to cope with the uneven floor conditions.



4. Tipping sideways
When this occurs, the forklift will start to tip sideways.

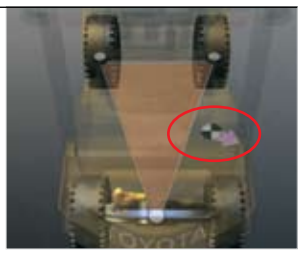


2. Area of Stability
As a result, the effective area of stability is a triangle.



5. Swing Lock Cylinder
To prevent this Toyota developed a steer axle locking device.

3. Centre of Gravity
The truck is in a stable situation until the centre of gravity moves out of the triangle of stability.



6. Larger Area of Stability
It temporarily locks the steer axle, transforming the triangle of stability into a rectangle.
The dramatic improvement in side stability will protect the driver and optimise productivity.

TOYOTA SAS Mast Function

The balance pivot between the counterweight and the load is in the centre of the front axle. A front tip over will occur when the position of the centre of gravity of the forklift moves forward, out of the stability area of the forklift. It happens when the centre of gravity of the rated load is too far forward.

6 Sensors

1 • Fork Height Switch

2 • Tilt Angle Sensor

3 • Front Tilt Limit Switch

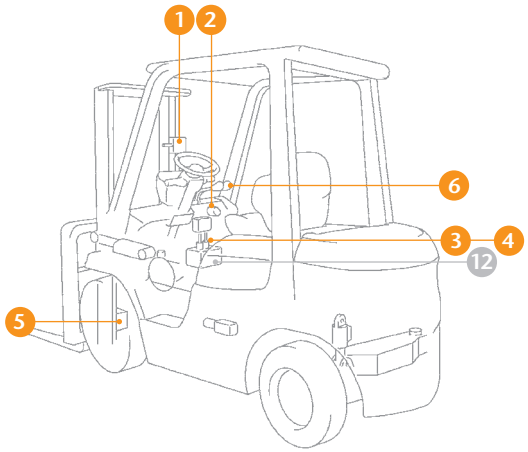
4 • Rear Tilt Limit Switch

5 • Load Sensor

6 • Tilt Knob Switch

1 Actuator

12 • Hydraulic Oil Control Valve



1. Forward tip-over
The risk of a forward tip-over increases proportionally as the load is raised and the mast tilted forward.

2. Forward Tilt Limit
When the truck is carrying a load above 2m, Toyota SAS limits the forward movement of the mast, therefore preventing accidental forward tip-over.

Losing load on back tilt: When can this happen?
Another danger tackled by Toyota SAS is losing loads when tilting backwards.

1. Back tilt
Normally, the backward tilting speed causes the mast to reach maximum backward angle abruptly, causing the load to fall

2. Backward Tilt Speed Limit
Toyota SAS will automatically reduce the backward tilting speed, avoiding such incidents

TOYOTA SAS Comfort Function

Auto Fork Levelling function

To stack or unstack a load, it is sometimes difficult to assess whether the forks are level with the ground or not. Auto Levelling allows the operator to automatically level his forks by depressing a button on the tilt lever, allowing him to be safer in the workplace and more efficient.

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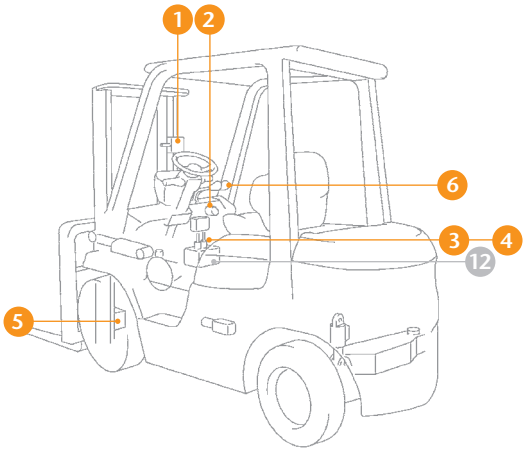


Active Steering Synchroniser function

On conventional full hydraulic power steering, there is no constant relation between the position of the knob on the steering wheel and the rear steering wheels. This increases the stress on the driver as he cannot rely on the position of the steering knob to tell him what direction his steering wheels are in.

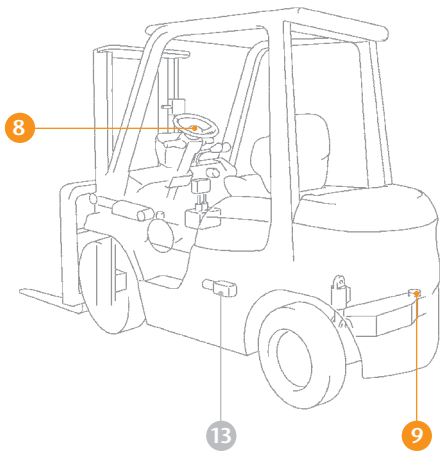
2 Sensors

8 • Steering Wheel Angle Sensor

9 • Tyre Angle Sensor

1 Actuator

13 • Steering Sychroniser Solenoid



Conventional Steering
No constant relationship between the position of the steering wheel and rear wheels.

Synchronised Steering
SAS ensures the steering knob always returns to the same position after a turn (at '8 o'clock' when driving in a straight line). The stress of the driver is reduced, and he is more efficient and safe in the workplace.

Definition

Toyota SAS is the world's first active safety system for forklifts which dynamically protects the driver and the load whilst increasing productivity and safety.

EC Stability Regulations and Key Statistics

EC Regulations State:
EN 1726:
"In order to restrict the hazards of longitudinal and lateral tip-over during normal operations, trucks (...) shall comply with the requirements specified in the stability tests (...), and not show any form of permanent deformation."
EN 1726:
"Sit-on (...) trucks with a lift height of more than 1800mm, shall be fitted with an overhead guard (...) to protect the operator."

Key Statistics[1] Show:
25.3% of fatal accidents are caused by truck tip-over.

14.4% of fatal accidents are caused by falling load.

Toyota SAS "The Concept":

Toyota developed a concept protected by 126 patents, which took over 2 years to develop with a team of more than 30 dedicated engineers.

It is a major safety breakthrough based on Toyota's experience in advanced automotive technology. For example, the sensor to detect side acceleration is similar to the one used in car navigation systems to assess whether the vehicle is turning left or right.

This development means Toyota went a step further to tackle the safety issues highlighted above with a dynamic System of Active Stability, called Toyota SAS.

Toyota SAS Models:

Toyota SAS is a standard feature for the following range:

Toyota IC forklifts from 1.5 to 5.0.

Toyota electric forklifts 1.0 to 5.0.

(1) US statistics OSHA from 1985 to 1990

Testimonials

"Because safety and comfort are integral to its design, our operators can drive the Generation 7 with complete peace of mind. Features like automatic fork levelling and active steering synchronisation vastly increase our efficiency."

Distribution Liaison Manager, Coca Cola Bottlers (Ulster)

"Toyota's System of Active Stability (SAS) is an important benefit for us. As the forklifts handle freight of all sizes, some of which are high value, it is vital that drivers feel confident operating the trucks."

"Toyota trucks meet all of our requirements and provide maximum efficiency. Toyota helps us to ensure complete customer satisfaction."

General Manager, British Airways Cargo

"The Toyota forklifts have contributed to our excellent health and safety record. The drivers also prefer them to any other trucks."

Health and Safety Manager, Inspirepac

"The stability of the forklifts and the active mast control feature also make the job so much easier; and there is a genuine feeling that the truck is quicker to manoeuvre than the competition"

Production Manager, Papermarc Merton Packaging

"The self levelling forks are a real asset as they save us time when lifting and placing pallets and help to reduce the risk of damage and therefore also save us money"

Partner, Evans and Radford, Spitalfields

"The stability of these trucks has been excellent. We need hard working trucks that the operators also feel comfortable in and so far the TOYOTA trucks have proved themselves well in these categories"

Fleet Manager, Bestway Group

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www.toyota-forklifts.co.uk