

Intelligent Robots with FANUC Force Sensors

Basic Description

Until now, robotic assembly has been dominated by 2-D applications using SCARA robots. FANUC Robotics' Intelligent Robots with integrated FANUC Force Sensors provide 3-D assembly with six degrees of freedom. The seamless integration of a six-degrees-of-freedom force sensor results in an intelligent robot that can "feel," enabling the most demanding mechanical assembly and material removal operations.

The Intelligent Robots include a standard FANUC robot (LR Mate[®] 200iC, M-10iA[™], M-16iB[™], M-710iC/50[™]), a FANUC Force Sensor (FS-30 and FS-60) and advanced force control software.

Standard sensor setup schedules and process specific force control instructions make the Intelligent Robots easy to program and operate via the FANUC *iPendant*[™].

Intelligent Robots provide process solutions for:

- Material removal applications including polishing, cutting, grinding, deburring and deflashing.
- Clutch insertion (intermediate, forward, reverse and triple clutch).
- Valve, bearing and shaft insertion.
- 3-D assembly applications including spline matching and gear assembly.
- Flexible part feeding.
- Product life cycle tests (e.g. automotive door operation, switching operation etc.) requiring constant force application.



Gear Phase Match



Precision Assembly

Features and Benefits

- **High reliability** – Intelligent Robots are built on standard mechanical arms with a high degree of reliability and proven performance records.
- **Simple to use** – Simple data setup menus for force control and standard teach pendant programming for application development make the Intelligent Robots simple to operate.
- **Color-graphic *iPendant* with patented browser-based interface** – Multiple-window, color-graphic interface allows simultaneous display of robot program, force setup and real-time force/moment (Fx, Fy, Fz, Mx, My, Mz) information during production operation.
- **Force data chart on *iPendant*** – Allows continuous display of actual force variations during the force control operation.
- **Safe to operate** – Intelligent Robots are compliant with applicable safety standards. Low speed teach mode switch and dual channel E-STOP interface make Intelligent Robots safe to operate in a production environment.

- **Easy to communicate with PC** – Built-in Ethernet communication capability allows Intelligent Robots to communicate relevant process data to a PC via Ethernet.
- **FANUC Force Sensor** – Is optimized for robotics, including small size and robust design.

Process Control Functions

Standard, schedule-based algorithms are provided to support a variety of common assembly and material removal processes. Once the force schedule is set, a simple force control instruction is added to the robot program to perform the insertion operation. Examples include:

- **Clutch insert** – Provides force and motion control to insert a clutch unit into an automotive automatic transmission. Clutch insert force schedule includes insert direction, contact force, approach velocity, push force, rotation limits, search frequency and search amplitude to perform the insert operation.

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- **Contouring** – Applies a constant force on the part surface while the robot-held tool moves along a path during polishing, cutting, grinding or deflashing operations. Contouring force schedules include approach velocity, contact force, push force and push direction information. Taught robot positions are dynamically shifted during the removal operation to provide the programmed force along the specified direction.
- **Phase match** – Performs variable spline matching prior to an insertion operation. Phase match force schedule includes initial contact force, push force, phase match torque, the rotation velocity, phase match depth and phase match time data.
- **Face match** – Provides uniform alignment between a robot held component and contact surface of a sub-assembly. It is useful for flexible machine loading, hotplate welding and spin welding applications.
- **Constant push** – Provides uniform pushing force while assembling or joining a workpiece to a sub-assembly.
- **Built-in Diagnostics** – Monitors sensor data and provides an alarm message to replace the sensor if the sensor data is out of range.



Shaft Insertion

FANUC Force Sensor Specifications

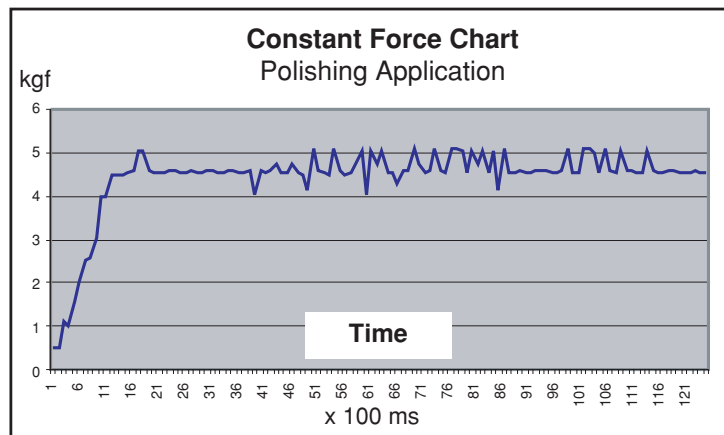
Items	FS-10i/A	FS-30	FS-60
Dimensions (mm)	90 x 43	108 x 75	152 x 80
Weight (kg)	0.56	1.3	2.8
Rated load Fx, Fy, Fz (kgf) Mx, My, Mz (kgf-cm)	10 80	30 300	60 1200
Static Overload Tolerance Fx, Fy, Fz (kgf) Mx, My, Mz (kgf-cm)	160 1280	300 3000	300 6000
Resolution Fx, Fy, Fz (kgf) Mx, My, Mz (kgf-cm)	0.040 0.160	0.15 0.5	0.24 1.4
Accuracy Fx, Fy, Fz Mx, My, Mz	2% or less	2% or less	2% or less



Polishing Application



Clutch Assembly



Example Teach Pendant Data Display

Intelligent Robot Solutions

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