Contents

1.0 Introducing the GEM Topaz-X

The Topaz-X, part of the GemLine (Modular High Speed Production Machines), is the newest addition to the top-of-the-line Philips' SMD pick & place machines. The Topaz-X is a High Speed flexible machine that can handle a wide range of components at speeds up to 18,000 SMDs per hour. The machine is built around a very rigid, vibration-free frame for improved accuracy and long-term stability and is perfectly suitable for round-the-clock production.

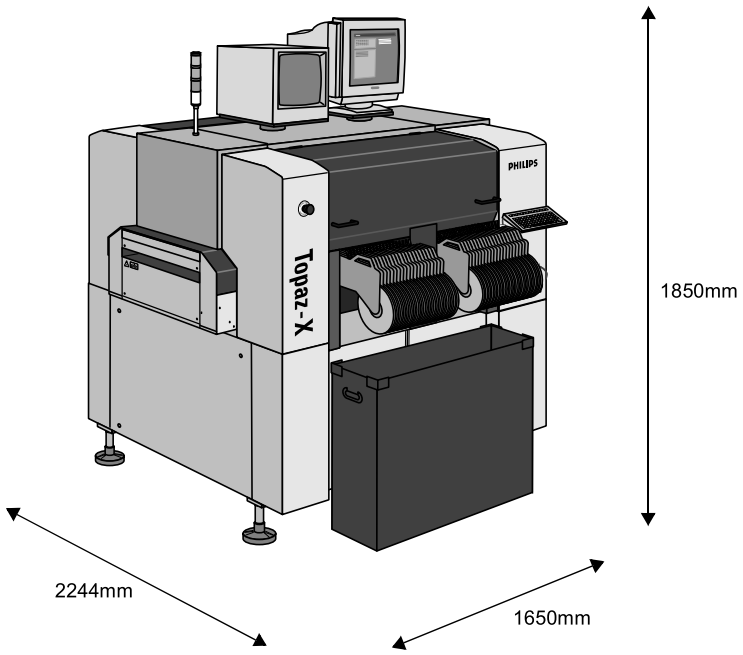


Figure 1 *Front view GEM Topaz-X.*

The GEM Topaz-X features a high precision single placement beam carrying 4 Flying Nozzle Change heads (each equipped with 3 nozzles) and 4 standard heads with exchangeable nozzles. The placement beam moves in X/Y and Z direction, while the board and component feeders are stationary. A flexible board transport system enables the Topaz-X to handle virtually any type of PCB, with or without tooling pins. Board conveyor width is automatically adjustable, allowing board dimensions up to 460 x 440mm (17.9" x 17.2") to be handled.

The newly designed vision system with Line Array camera allows fast and accurate "on-the-fly" alignment of a wide range of components from 0201 up to 32mm square PLCC, including 32mm square QFPs with lead pitches down to 0.5mm (20 mil). Dark background BGAs, µBGAs and CSPs with ball pitches down to 0.75mm (31 mil) and ball diameters down to 0.3mm (12 mil) can be recognized with the use of a new developed illumination unit which allows measurement of ball positions and dimensions.

An optional single area CCD camera extends the component range to 32mm square ICs with lead pitches down to 0.4mm (16 mil). The vision system detects missing, bent or irregular spaced leads or BGA balls; faulty components are rejected.

A separate camera system monitors fiducial marks at the board, circuit and component level, using a combination of white-light and IR LEDs with multi-angle diffusers to provide optimal illumination.

Just five nozzle shapes are required to cover the specified SMD range. High output levels are therefore achieved, as the need for nozzle exchanges is minimal. An optional 18 position nozzle exchange station enables additional special nozzles to be accommodated.

Up to 90 tape feeders can be loaded on the GEM Topaz-X. The machine supports tape, stick, bulk and tray feeders.
The tape feeder design for the GEM Topaz-X allows simultaneous picking from any mix of tape feeders ranging from 8 to 44mm.

An industrial PC controller, running Philips well proven and user-friendly software, allows the GEM Topaz-X to be used stand-alone or in-line. The controller includes a Management Information System (MIS) that continuously gathers production data for management feedback. The unique bad mark sensing capabilities allow a multi-circuit panel to be run as one large board, thus maximizing placement speed while still using bad mark information. A laser-based verification system, which guarantees correct feeder latching, is standard.

The GEM Topaz-X is fully compatible with the Sapphire, Topaz, Emerald and Emerald-X, which use the same feeders, feederbars, software and controller.

A basic program optimization function is also included in the machine as standard. For more advanced machine optimization and/or line balancing, the new Production Preparation System for GemLine allows you to create and optimize SMD machine programs on a PC instead of using the SMD machine. This reduces line change-over time and prevents errors.

2.0 General Specifications

GEM Topaz-X		
		REMARKS
Tact time:	0.20sec/chip with line array camera	Simultaneous pick with 8 heads
	0.45 sec/SO with line array camera	Simultaneous pick with 4 heads
	1.4 sec/QFP with line array camera	Sequential pick with 4 heads
	3.7 sec/QFP with area CCD camera	In fine mode with 1 head
Optimal placement rate:	18,000 cph	Simultaneous pick with 8 heads
Nominal placement rate:	12,000 - 14,000 cph	
Applicable components:	0201 - SOP, SOJ, PLCC 32mm ⍁ (1.26") 6mm - QFP 32mm ⍁ (1.26") with pin pitch down to 0.5mm (20 mil) Dark background BGA, µBGA, CSP with regular pitches; 6mm - 32mm: Min. ball pitch down to 0.75mm (31mil), Min. ball diameter down to 0.3mm (12mil)	Line array camera system
	6mm - QFP 32mm ⍁ (1.26") with pin pitch down to 0.4mm (16 mil) Dark background BGA, µBGA,CSP with regular pitches; 6mm - 32mm: Min. ball pitch down to 0.75mm (31mil), Min. ball diameter down to 0.3mm (12mil)	Optional 32mm area CCD camera system with fore and side illumination unit
Mounting accuracy: (X,Y) 3σ	± 75µ for chips and SOIC ± 60µ for QFPs (6mm - 32mm ⍁ 1.26") with pin pitch down to 0.5mm (20 mil)	Line array camera system (all placement heads and all placement angles)
	± 35µ for QFPs (6mm - 32mm ⍁ 1.26") with pin pitch down to 0.4mm (16 mil)	Optional area CCD camera system (in fine mode)
Mounting accuracy: (φ) 3σ	For Chips and SOIC this is Lead dependent ± 0.6° for QFPs (6mm - 32mm ⍁ 1.26") with pin pitch down to 0.5mm (20 mil)	Line array camera system (all placement heads and all placement angles)
	± 0.09° for QFPs (6mm - 32mm ⍁ 1.26") with pin pitch down to 0.4mm (16 mil)	Optional area CCD camera system (in fine mode)
Mounting angle:	0 up to 360 (programmable in steps of 0.01)	
Mounting repeatability: 3σ	X, Y 30µ for QFPs (6mm - 32mm ⍁ 1.26") pitch 0.4 Phi (0.09°)	
Number of heads:	One single beam with 4 Flying Nozzle change heads and 4 standard heads	The Standard heads can exchange nozzles with the use of the optional Nozzle Exchange Station
Alignment system:	One line array camera with fore and side illumination system for Vision on the Fly using the VICS 2500 processing system	Standard, second line array camera is optional
	Area CCD camera for QFP 32mm ⍁ (1.26") with pin pitch down to 0.4mm (16 mil)	Optional
	Moving CCD camera for Fiducial alignment	Standard

GEM Topaz-X		
		REMARKS
Type of nozzles:	Type 71F (on FNC head) Type 72F (on FNC head) Type 73F (on FNC head) Type 71A Type 72A Type 73A Type 74A Type 76A (Melf nozzle)	Standard will be delivered: 4x nozzle 71F, 4x nozzle 72F, 4x nozzle 73F, 4x nozzle 72A
Nozzle exchange station:	18 nozzle positions	Optional (No nozzles included) Nozzle station can hold: 4 × 71A, 4 × 72A, 4 × 74A, 4 × 76A and 2 special nozzles; Nozzle 73A does not fit in the nozzle station
Component weight:	Max: 10 gr.	With the use of nozzle type 74A
Component height:	Max: 4.0mm	Max: 6.5mm depending on mount sequence. Placing of parts with a height of 6.5mm - 10mm is possible if certain conditions are met.
Component mounting interdistance:	Chip: 0.5mm or more SOP: 0.7mm or more	
Placement system:	Pneumatic or servo controlled for component height compensation	
Placement force:	24 gram/mm (for nozzles with buffer this value is different)	Pre-tension is 200 gr. (spring loaded)
Number of feeders:	Tapefeeders:	
	8mm: 90 positions	
	12mm: 43 positions	
	16mm: 43 positions	
	24mm: 28 positions	
	32mm: 22 positions	
	44mm:21 positions	
	Stick feeders: Depends on stick dimensions	

GEM Topaz-X		
		REMARKS
Component packaging:	Tape according to IEC/EIA-J/JEDEC: 8-44mm *For larger tape feeders such as 56mm, 72mm please contact your local sales representative.*	Tape reel diameter max: 380mm (15")
	Manual Tray feeder: Max. tray size is board width dependent: Max tray size: 330mm x 300mm (12.8" x 11.7") Max tray size by max board width of 440mm (17.2"): 330mm x 175mm (12.8" x 6.8") Min tray size 50mm x 50mm (2.0" x 2.0")	Optional: Manual tray feeder (Max. number of feeders 65, Head number 8 can't pick components in an area of 14mm from the right side of the MTF
	ATS 20 Tray Feeder portrait: Max. tray size: 220mm x 350mm (8.6" x 13.7") Min tray size 50mm x 50mm (2.0" x 2.0")	Optional (factory built in): ATS 20 Tray Feeder portrait (Max. board width 250mm (9.8"), max. number of 8mm feeders 3 x 20, amount of pallets 20 with 12.5mm pitch)
	Double ATS 20 Tray Feeder portrait: Max. tray size: 220mm x 350mm (8.6" x 13.7") Min tray size 50mm x 50mm (2.0" x 2.0")	Optional (factory built in): Double ATS 20 Tray Feeder portrait (Max. board width 250mm (9.8"), max. number of 8mm feeders 2 x 20, amount of pallets 2 x 20 with 12.5mm pitch, at the left ATS 20 components can't be picked by all heads in an area of 36mm from the left side of the ATS 20)
	ATS 20 Tray Feeder landscape: Max. tray size: 350mm x 220mm (13.7" x 8.6") Min tray size 50mm x 50mm (2.0" x 2.0")	Optional (factory built in): ATS 20 Tray Feeder landscape (Max. board width 380mm (15.0"), max. number of feeders 2 x 20 + 16, amount of pallets 20 with 12.5mm pitch, at the right side of ATS components can't be picked by all heads in an area of 18.2mm)
	Double shuttle LCS Tray Feeder: Max. tray size: 350mm x 440mm (13.7" x 17.2") Min tray size 50mm x 50mm (2.0" x 2.0")	Optional: Double shuttle LCS Tray Feeder (no restrictions) Max: 120 Jedec trays
	Stick and bulk	Many solutions possible
Maximum height pre-mounted components:	4.0mm on placement side (0.16") 18mm on non placement side (0.7")	
PCB Dimensions (x,y):	Min: 50mm x 50mm (2.0" x 2.0") Max: 460 x 440mm (18" x 17.2") *Special applications upon request*	Using PCB pin fixation or edge clamping system.
PCB Weight:	Max. 1.2 Kg Max. 2.0 Kg	Without components With components
PCB Thickness:	Min: 0.4mm (0.015") Max: 4.0mm (0.15") *Special applications upon request*	

GEM Topaz-X		
		REMARKS
Non-mountable area:	Board top side: 3mm (0.12") from rear side board edge 0mm from front side board edge	Component height restrictions apply in the 10mm (0.40") area from front side edge depending on board thickness
	4mm (0.16") around reference holes (locate pins)	Flat edge of 30mm (1.2") is required on bottom right corner for the use of the main stopper, sub and exit stopper
	Board bottom side: 5mm from front and rear side board edge (0.2")	
		For ceramic PCBs (optional) the non-mountable area may be different
PCB Material:	Phenolic/FR4/Composite Materials	Ceramic PCBs require special conveyor sections (optional)
PCB Positioning:	Locate pin fixation	Adjustable second pin
	Z servo controlled push up system	Software controlled by PCB thickness
	Push up pins	Adjustable positions
	Edge clamping	With adjustable push in
	Sub stop (PCB waiting buffer)	Adjustable position
	Exit stop	Fixed position
PCB Transport height:	900mm ± 10mm (35.4" ± 0.4")	Standard
	SMEMA 953mm ± 12.5mm (37.5" ± 0.5")	Standard
PCB Transport direction:	Left to Right	Right to Left is optional
PCB Transport width:	Automatic	Front rail fixed Rear rail adjustable
PCB Loading time:	Approximately 3 sec.	PCB loading concurrent to SMD picking and alignment
PCB Ratio width/length:	Max. 1:3	
Control system:	MCX controller 486-100	100 MHz, 16 Mb intern. memory
	40 Mb flash disk	Optional 85 Mb
	1.44 Mb floppy drive 3.5"	
	RS 232 Serial Interface	
	15" Color Monitor	
	9" Black/White vision monitor	
User interface:	VIOS (Visual Integrated Operating System)	
	Hand held keyboard for all operator functions	
	Enhanced PC/AT keyboard for data editing functions	

GEM Topaz-X		
		REMARKS
Control system functions:	Max. 127 PCBs	Max. 2560 components per PCB
	Backup and restoring data using RS232 serial line or floppy	
	Data conversion UFOS↔VIOS	
	Data conversion Text↔VIOS	
	MIS data gathering	
	Data teaching	
	Data tracing	
	Component database	3000 Component packages; user can define and teach vision files
	Mark database	300 Mark shapes
	SMEMA electrical interface	
	On line calibration	
	On line help functions	
	Feeder lock verifier	
Machine dimensions and weight:	Length: 1650mm (5.4 ft)	
	Height: 1850mm (6.1 ft)	
	Width: 1408mm (4.5 ft)	Width including feeders is 2244mm (7.36 ft)
	Weight: 1570 kg (3460 Lbs)	
Safety standards:	EN 292, EN 294, EN 349, EN 614, EN 1050, EN 55011, EN 50082-1, EN 60204-1	CE-safety is part of system design. Safety measurements are tested on each product in the factory.
	Electrical safety according IEC 204	
Warning lights:	White: Emergency stop, safety cover interlock Blue: Pick up error, out of components Green: in automatic operation	
Electric power:	Voltage AC: 200/208/230/240/380/400/416 V ± 10%, 3 Phase	More than 2.5mm^2 cables are needed
	Frequency: 50/60 Hz	
	Consumption: 4 kVA max.	
Air supply:	Pressure: > 5.5.10^5 Pa (5.5 bar, 80 PSI)	
	Quality: dust and oil free	
	Consumption: 350 Nl/min.	
Operating temperature:	15-35° C (59° - 95° F)	Specification guaranteed: 20° - 28° C (68° - 82° F)
Humidity:	20 - 90% (no dew)	
Noise:	< 78dBa	

Table 1

3.0 Features, Accessories and Options

3.1 Features

The standard GEM Topaz-X includes the following features:

- On the fly alignment using a vision system with a Line Array camera standard equipped with a side illumination unit for BGAs, µBGA, CSP components.
- Placement beam with 4 Flying Nozzle Change heads (each head standard equipped with 3 nozzles) and 4 standard heads.
- Simultaneous picking is possible by all 8 heads from any mix of tape feeders (except for 0201 components). This allows a much higher nominal placement rate and board throughput.
- Complete component range can be handled with only 5 nozzles shapes.
- Fiducial alignment camera with improved software controlled illumination unit (white + IR Leds), that also can be used as teaching/tracing device and for Bad Mark sensing.
- Automatic width adjustment. The PCB dimension is included in your PCB data.
- PCB pin-positioning. Second pin is easily adjustable for fast changeover.
- PCB edge clamping system, for PCBs without tooling holes.
- PCB push up plate (Z servo controlled) with 12 push up pins, for PCB support. PCB thickness is included in the PCB data.
- Substopper, allowing a second PCB to enter the machine for reducing transport time.
- Exit Substopper, allowing a new PCB to enter the work area of the machine while the downstream machine is still not ready to accept a new PCB.
- Feeder lock verification system to avoid damage to the machine due to incorrectly latched feeders.
- 3.5" FDD for backup purposes.
- Component dump box.
- Operator manual, available in different languages.
- User manual.
- Service manual.
- Two empty tape bins.
- Toolset.

- First aid spare parts kit.
- CE safety.
- ESD safety.
- Electrical and Mechanical SMEMA.

Standard Software features:

- Variable XY axis speed per component (*new*).
- Datum angle functionality (especially for stick components, there is no pick angle necessary to recognize the component which results in higher output). (*new*)
- User Friendly Human interface VIOS (Visual-Integrated-Operating-System).
- An On-line help function allows display of detailed descriptions of operations and functions on screen.
- Management Information System (MIS) to gather production history data.
- 4 point fiducial correction, to maintain accuracy for stretched/distorted boards.
- Template (pattern) matching for PCBs that have no fiducials.
- Different mark shapes for fiducial pair possible.
- Box teaching to recover fiducial recognition error.
- Data editing functions with the use of the fiducial camera (teaching, tracing).
- A Component database, that can hold up to 3000 component packages, with the most frequently used components already predefined.
- A Mark database, that can hold up to 300 mark shapes, with the most frequently used mark shapes already predefined.
- Precede pick-up, allowing to pick up components before the PCB is fixed, reducing cycle time.
- Alternative feeder function, reducing operator intervention (empty feeder switching).
- Automatic program change over for family boards (self production control).
- Automatic rework cycle to improve operator efficiency and on-line optimization, to keep mounting speed during production in case of empty feeders. Detected empty feeders are automatically skipped until end off programs, to allow one time replenishment.
- Product preparation can be done on the machine including basic optimization of the mount program. (nozzle and feeder set-up).

- Multi-section PCBs can be either be mounted block-by-block or the block data can be combined to achieve the fastest mounting sequence. In the latter case, block badmarks still remain in effect.

3.2 Accessories and Options

Accessories and options Topaz-X	
PA 1912/00	CSM/GEM Glass Adjustment Kit
PA 2695/12	Manual Tray Feeder Topaz-X/Emerald-X
PA 2696/21	ATS 20 Tray Feeder portrait for GEM
PA 2696/22	Double ATS 20 Tray Feeder portrait for GEM
PA 2696/23	ATS 20 Tray Feeder landscape for GEM
PA 2699/22	Double shuttle Tray Feeder (LCS) for Topaz-X/Emerald-X
PA 2903/20	16mm Tape Feeder, 15 inch reelholder FV/GEM
PA 2903/25	16mm Tape Feeder, 15 inch reelholder FV/GEM PSA
PA 2903/30	24mm Tape Feeder, 15 inch reelholder FV/GEM
PA 2903/35	24mm Tape Feeder, 15 inch reelholder FV/GEM PSA
PA 2903/40	32mm Tape Feeder, 15 inch reelholder FV/GEM
PA 2903/45	32mm Tape Feeder, 15 inch reelholder FV/GEM PSA
PA 2903/50	44mm Tape Feeder, 15 inch reelholder FV/GEM
PA 2903/55	44mm Tape Feeder, 15 inch reelholder FV/GEM PSA
PA 2903/73	8mm Tape Feeder for 0201, 2mm pitch, 7 inch reelholder FV/GEM (PSA)
PA 2903/74	8mm Tape Feeder, 2mm pitch, 7 inch reelholder FV/GEM (PSA)
PA 2903/75	8mm Tape Feeder, 4mm pitch, 7 inch reelholder FV/GEM (PSA)
PA 2903/76	8mm Tape Feeder, 4mm pitch, 15 inch reelholder FV/GEM (PSA)
PA 2903/85	12mm Tape Feeder, 7 inch reelholder FV/GEM PSA
PA 2903/86	12mm Tape Feeder, 15 inch reelholder FV/GEM PSA
PA 2906/10	Reject conveyor for Topaz-X and Emerald-X
PA 2923/00	Set of 20 dummy feeders
PA 2962/41	Nozzle Type 71A (0201-0420/0603-1005)
PA 2962/42	Nozzle Type 72A (0603-1206/1608-3216)
PA 2962/43	Nozzle Type 73A (1812-SOP/4532-SOP)
PA 2962/44	Nozzle Type 74A (Middle size QFP)

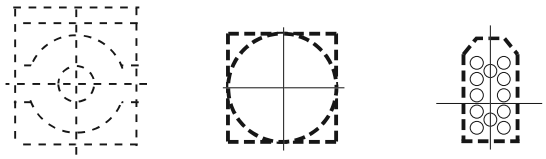
PA 2962/46	Nozzle Type 76A Cylindrical chip (MELF)
PA 2963/16	Nozzle Exchange System Topaz-X (18 position no nozzles included)
PA 2969/51	Second Line Array camera for Topaz-X
PA 2969/53	Second Line Array camera in combination with ATS (factory built in only)
PA 2969/91	Area CCD camera 32mm (including fore and side illumination unit) for Topaz-X
PA 2981/15	Pallet for LCS Tray Feeder FV/GEM (PA 2699/22)
PA 2981/35	Pallet for PA 2696/21 and PA 2696/22 (ATS 20 portrait)
PA 2981/36	Pallet for PA 2696/23 (ATS 20 landscape)

Table 2

3.3 Machine configuration examples

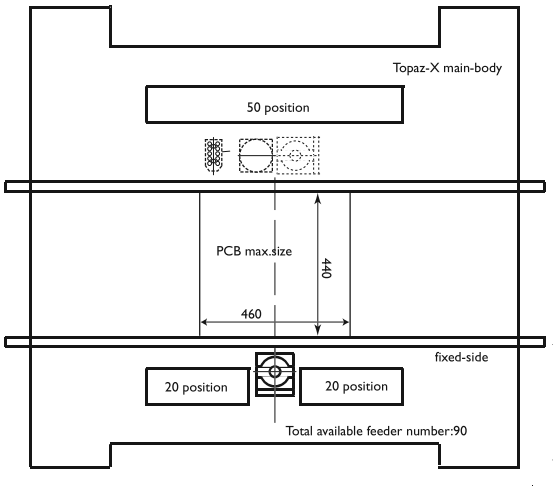
On the following pages you can find some machine configuration examples for the Topaz-X.

Remark: In the examples the dotted line pictures indicate the physical position of the second line array camera, area CCD camera and nozzle exchange station. These can be ordered as an option.



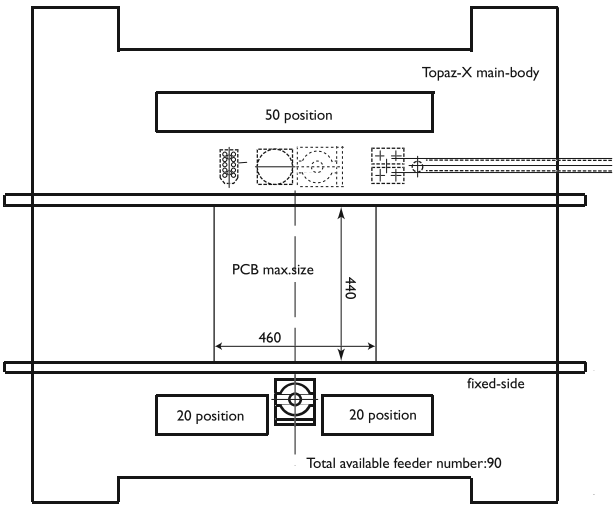
1. Second line array camera.
2. Area CCD camera Topaz-X.
3. Nozzle exchange station for Topaz-X.

Example 1: Topaz-X



PA 1312/01 Topaz-X
PA 2963/16 Nozzle Exchange System Topaz-X (18 positions/no nozzles include
PA 2969/51 Second line array camera Topaz-X
PA 2969/91 Area CCD camera 32mm (including lighting unit) for Topaz-X

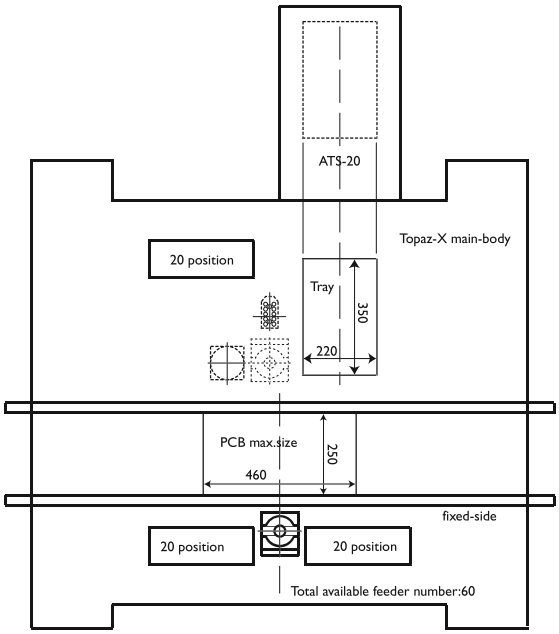
Example 2: Topaz-X with double shuttle LCS



PA 1312/01 Topaz-X
PA 2699/22 Double shuttle LCS
PA 2963/16 Nozzle Exchange System Topaz-X
(18 positions/no nozzles included)
PA 2969/51 Second line array camera Topaz-X
PA 2969/91 Area CCD camera 32mm (including lighting unit) for Topaz-X

Figure 2 Machine configuration examples 1 to 5 (see also next pages)

Example 3: Topaz-X with ATS-20 portrait



PA 1312/01 Topaz-X

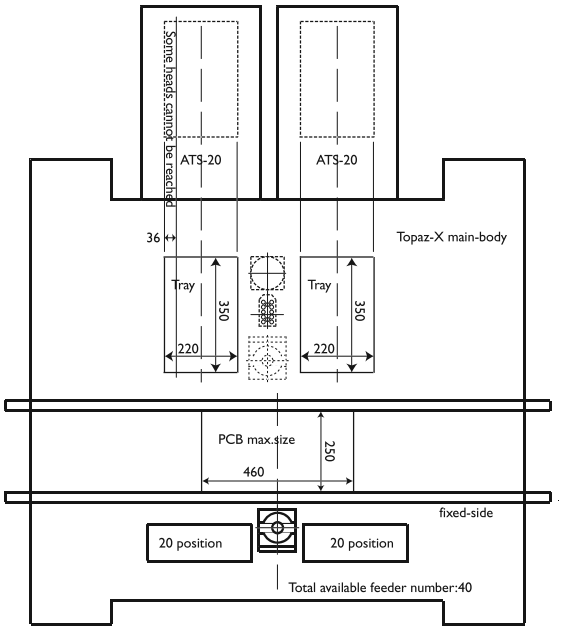
PA 2696/21 ATS-20 tray feeder portrait

PA 2963/16 Nozzle Exchange System Topaz-X (18 positions/no nozzles included)

PA 2969/53 Second line array camera (only factory built in)

PA 2969/91 Area CCD camera 32mm (including lighting unit) for Topaz-X

Example 4: Topaz-X with double ATS-20 portrait



PA 1312/01 Topaz-X

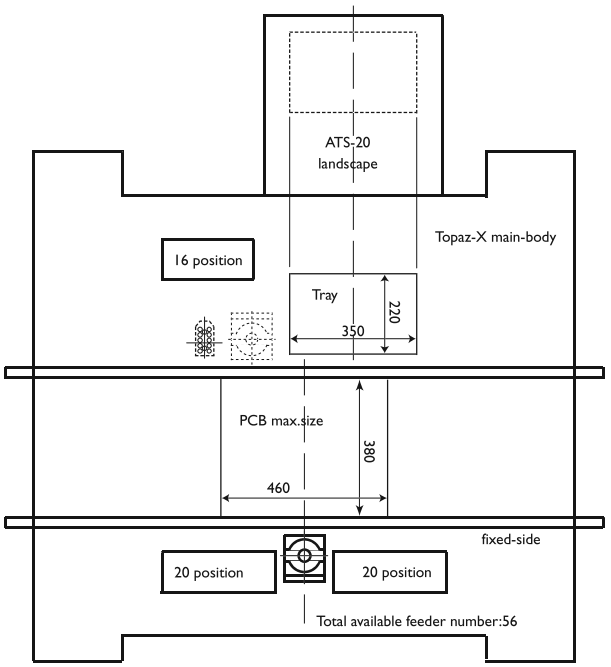
PA 2696/22 Double ATS-20 tray feeder portrait

PA 2963/16 Nozzle Exchange System Topaz-X (18 positions/no nozzles included)

PA 2969/53 Second line array camera (only factory built in)

PA 2969/91 Area CCD camera 32mm (including lighting unit) for Topaz-X

Example 5: Topaz-X with ATS-20 landscape



PA 1312/01 Topaz-X

PA 2696/23 ATS-20 tray feeder portrait

PA 2963/16 Nozzle Exchange System Topaz-X (18 positions/no nozzles included

PA 2969/53 Second line array camera (only factory built in)

or

PA 2969/91 Area CCD camera 32mm (including lighting unit) for Topaz-X

4.0 Mounting Heads Configuration

The GEM Topaz-X features a high precision single placement beam carrying 4 Flying Nozzle Change heads (each equipped with 3 nozzles) and 4 standard heads with exchangeable nozzles and a separate camera system that monitors fiducial marks at the board, circuit and component level, using white + IR light LEDs and multi-angle diffusers to provide optimal illumination. High placement rates are achieved by simultaneous component picking which reduces head beam travel and thus shortens the mounting cycle.

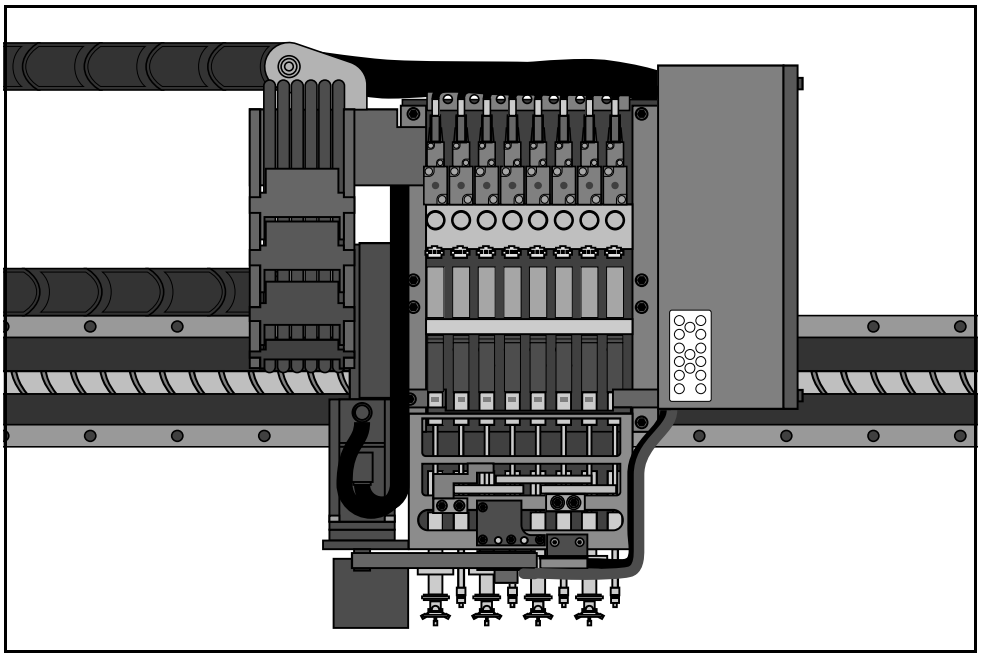


Figure 3 *Configuration of head section.*

The high-precision dual Y drive Topaz-X features four-axis (X,Y,Z,R) servo control for accurate, stress-free component mounting. Direct drive, brushless AC motors controlling heavy duty lead screws allow optimal accuracy and high reliability.

Specifications	
Number of axis:	7
Axis configuration:	X axis AC servo Double Y axis AC servo Z , R axis AC servo W (automatic width) axis AC servo Push up plate AC servo
Z axis sequence:	Air and AC servo motor
R axis sequence:	AC servo motor
Pick-up error detection:	Vacuum check (256 level digital setting)
Mounting angle:	0° - 360° (0.01° step)
Number of mounting head:	8 in-line multi head
Nozzle types:	5 different shapes
Encoder resolution:	X,Y = 0.00122mm/pulse
	Phi = 0.0146°/pulse
	Z = 0.00048mm/pulse
Speed:	X = 1500mm/sec
	Y = 1500mm/sec
Acceleration:	X = 36600mm/sec^2
	Y = 27000mm/sec^2

Table 3

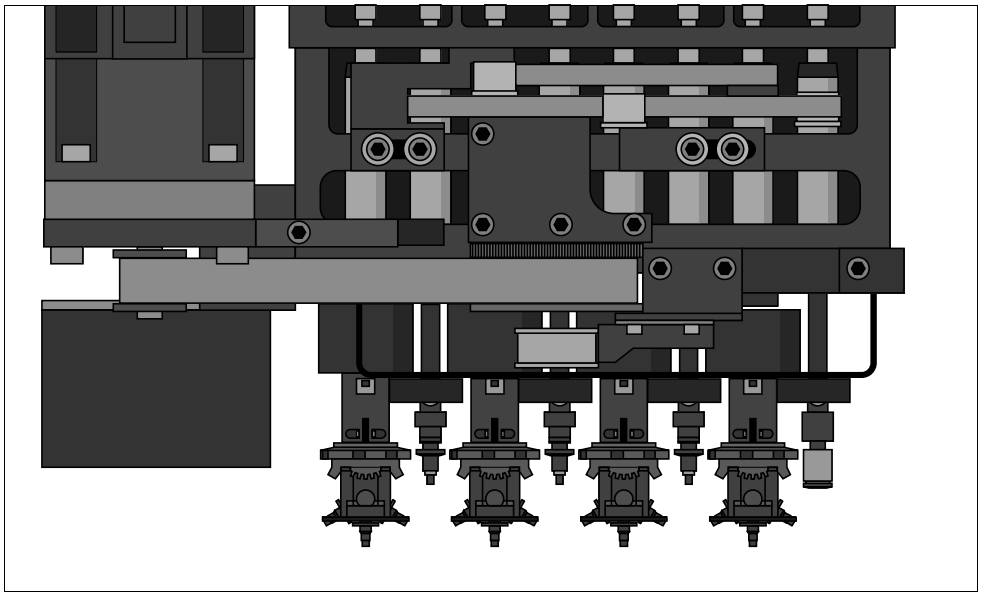


Figure 4 *Head section detail.*

5.0 Alignment

5.1 Line Array Camera Alignment

The high speed of the GEM Topaz-X is achieved by fast on-the-fly component alignment using a revolutionary Line Array camera system, equipped with a newly developed multi angle illumination unit, that is four times faster than conventional systems. For ultimate speed, the machine can be equipped with a second Line Array camera which reduces head beam travel and thus shortens the mounting cycle.

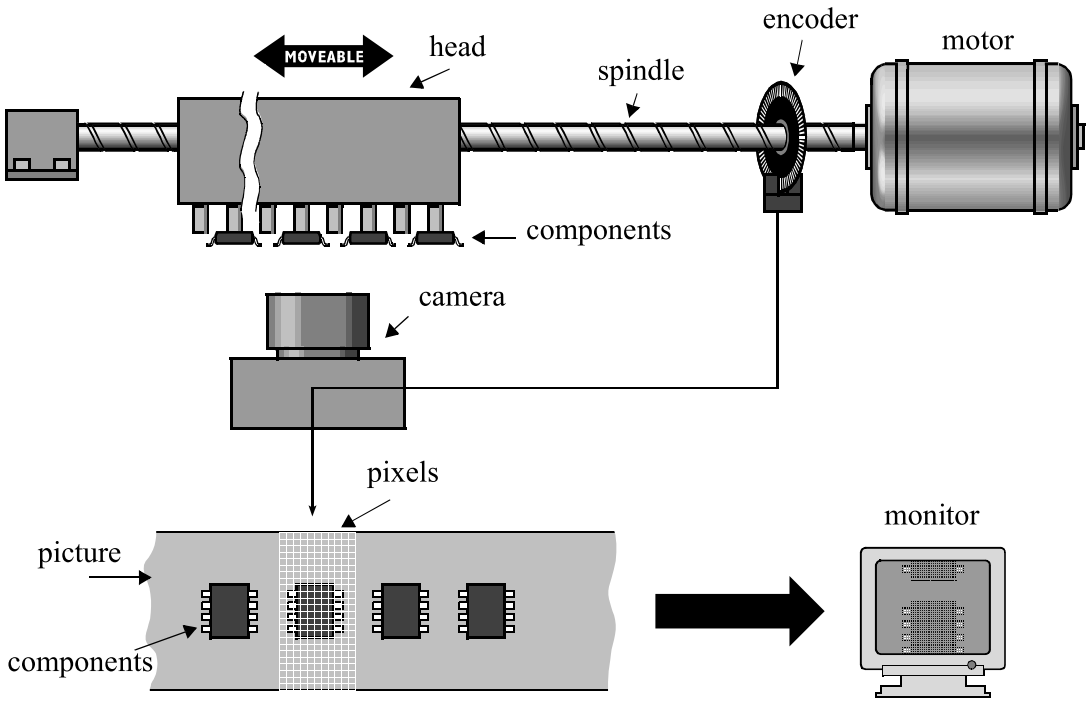


Figure 5 *Line sensor vision principle.*

While moving the beam over the camera, the encoder triggers the camera to capture consecutive lines of pixels. All these lines form the total picture of the components. This picture is processed by a sophisticated vision system. The vision system algorithms inspect the components and calculate position and orientation of the components on the heads.

The SMD components are illuminated by a new developed multi angle side illumination unit which allows high speed recognition of CSPs, µBGAs. The leads of the components are imaged on the line sensor.

Specifications	
Line Array camera:	CCD 2048 x 1 pixels
Max. component size:	32mm ⍁ (1.26")
Min. component size:	0201
Min. lead pitch:	0.5mm (20 mil)
Min. lead width:	0.2mm (0.008")
Grey scale:	256 levels
Lighting:	Multi angle Fore/side illumination Light intensity is software controlled for each component separately
Recognition:	Reflection. Pattern recognition on all leads
Max. number of lead sides:	4
Max. number of lead groups:	2 per side
Check on:	Lead/ball pitch
	Lead/ball location
	Bent/missing leads/balls
	Total number of leads/balls
	Cumulative lead/ball pitch

Table 4

5.2 Single Area CCD Alignment

An optional single area CCD camera extends the component range for the GEM Topaz-X.

Component illumination is performed by means of fore/reflective lighting and side illumination. The lighting source reflects the lead of QFP and the balls of BGA components on the CCD camera. The single area CCD camera grabs the image of the component in one frame and presents it to the vision system for recognition and measurements purposes.

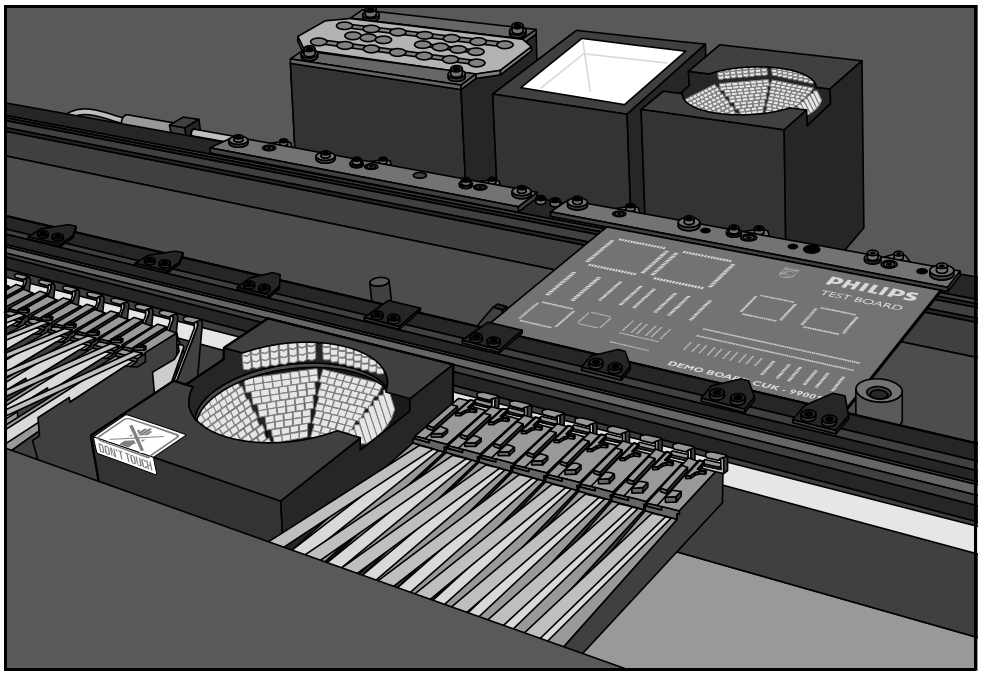


Figure 6 *GEM Topaz-X working area.*

Specifications	
Area CCD Camera:	CCD 512 x 480 pixels
Max. component size:	32mm ∅ (1.26")
Min. component size:	6mm ∅ (0.24")
Min. lead pitch:	0.4mm (16 mil)
Min. lead width:	0.2mm (0.008")
Grey scale:	256 levels
Lighting:	Fore/side lighting illumination
Recognition:	Reflection. Pattern recognition on all leads
Max. number of lead sides:	4
Max. number of lead groups:	2 per side
Check on:	Lead/ball pitch
	Lead/ball location
	Bent/missing leads/balls
	Total number of leads/balls
	Cumulative lead/ball pitch

Table 5

5.3 Fiducial Alignment

The GEM Topaz-X is standard equipped with a fiducial camera. This camera is used to compensate for variations in the position of the circuit pattern relative to the expected position. The fiducial alignment system is an opto-electronic system which performs geometric measurements of fiducial marks on the PCB in order to calculate the deviations from their expected positions. The system can use two or four fiducials per board. Each sub-circuit can also be aligned using two fiducials. For placement of fine-pitch components two local fiducials per component may be used. The individual shapes of a fiducial pair can be different to allow for maximum application flexibility. Also pattern recognition algorithms can be used on traces or pads on the PCB board for cases where fiducials are not available.
The fiducial camera can also be used as a high accurate teaching device for PCB data (if CAD data is not available), automatic calibration and inspection purposes.

Specifications	
Fiducial camera:	CCD
Fiducial camera functionality	Fiducial detection, Bad Mark detection, teaching device (2 or 4 point teaching)
Fiducial illumination:	White + IR LEDs in conjunction with a multi-angle illumination
Compensation for: (with two fiducials)	Translation Rotation Linear stretch and shrink
Compensation for: (with 3 or 4 fiducials)	Non-linear stretch and shrink
Type of compensation:	PCB, Block, Local
Fiducial size:	Max. 3.0mm (0.12")
	Min. 0.8mm (0.03")
Fiducial material:	Copper Gold Lead-tin
Fiducial clearance area	2 x Fiducial size
PCB warpage at fiducial:	Max. 0.5mm (0.02")
Pattern offset:	Max. 1mm (0.04")
Number of different Fiducial pairs per PCB:	128
Number of fiducial shapes in Mark Database:	300
Examples of fiducials:	Solid circle (preferred) Square Triangle Donut Binary cross Bow-tie (connected) Template matching (art work)
Fiducial definition:	According CAD data

Table 6

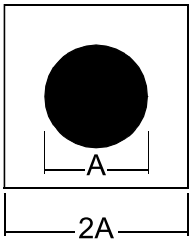


Figure 7 *Fiducial free space.*

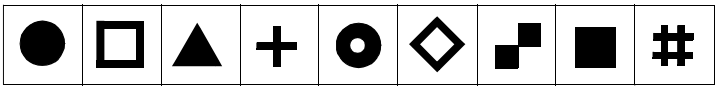


Figure 8 *Examples of fiducials.*

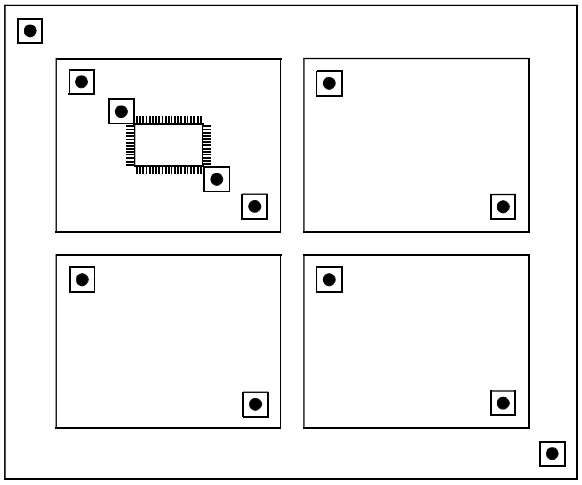


Figure 9 *Examples of PCB, block and local fiducials.*

5.4 Master, Bad Mark Sensing

If the PCB contains subcircuits, one or more of these subcircuits can be skipped for placement by giving them a “Bad Mark” on a designated position on the subcircuit. No parts will be placed on a circuit that has a Bad Mark. Bad Mark sensing, with the use of the fiducial camera, is based on recognition of a difference in contrast in a certain area. This area can be defined in the machine software (position and area-dimensions). This gives maximum freedom in choosing the process or technique to add Bad Marks, for example:

- white or light colored labels of any dimension,
- white paint,

... or any other material that can be fixed as long as it contrasts with the PCB surface.

Before checking the Bad Marks on all circuits, the Master Mark may be checked first. Presence of a Master Mark means that one or more Bad Marks are present on the circuits. This allows the machine to skip the Bad Mark sensing process for all circuits if no Bad Marks are located on the circuits, therefore saving valuable production time.

6.0 Board Handling

PCB boards can be located in the machine by either tooling pins or edge clamping if tooling holes are not available. With pin location, one location pin is fixed on the machine while the other locate pin is easily adjustable when the board length changes. Change over to a different board size is just a matter of seconds by using the automatic adjustment (servo controlled) of the conveyor width and the PCB thickness.

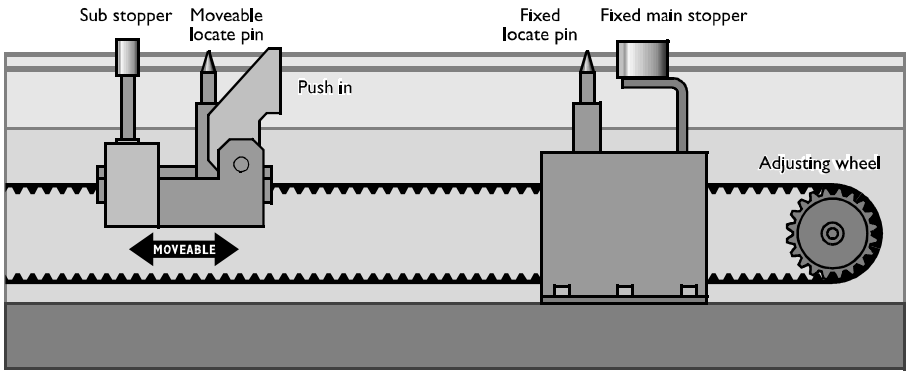


Figure 10 *Pin fixation system.*

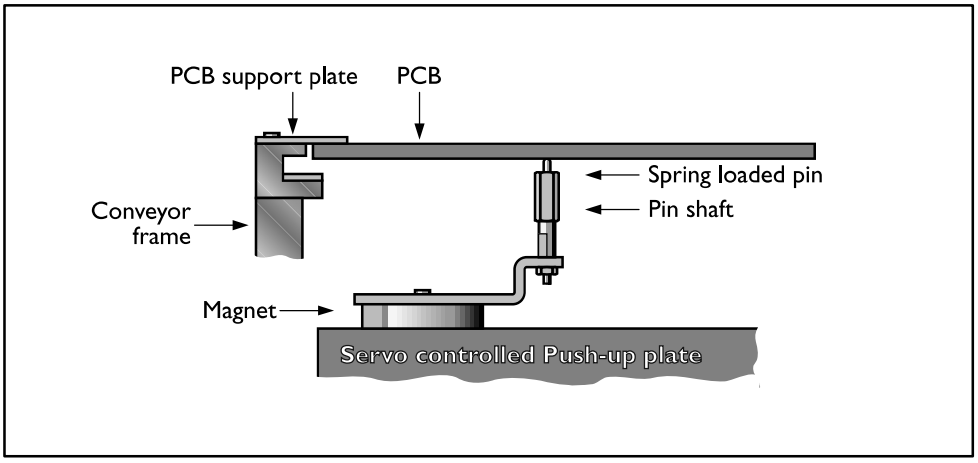


Figure 11 *Push up system.*

The Edge Clamping system is as easy to adjust as the locate pin fixation. Both these systems use Push-up pins to support the PCB.

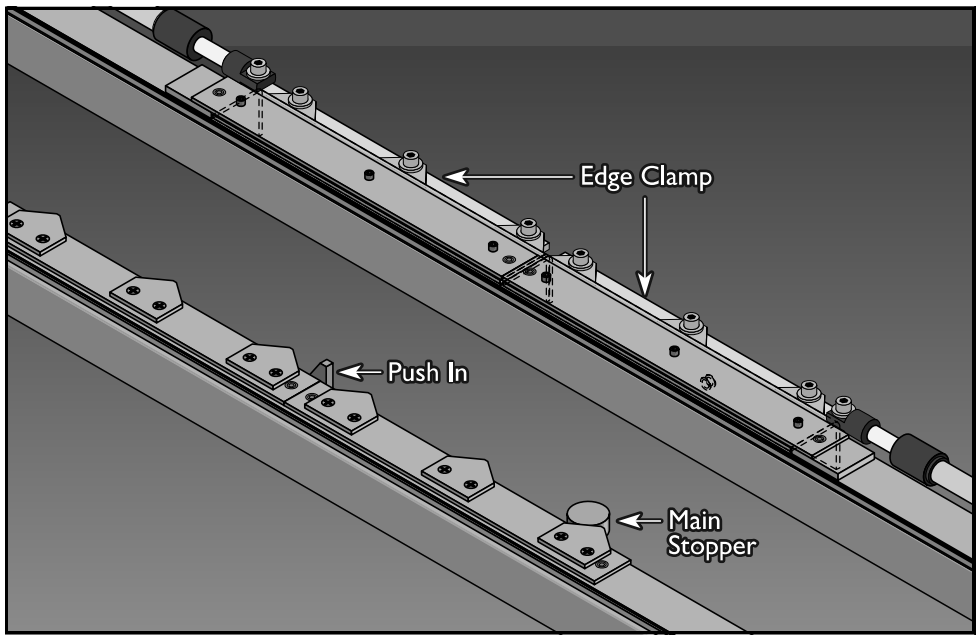


Figure 12 *GEM Topaz-X Edge Clamping system.*

A sub-stop enables an additional PCB to enter the machine while the current board is being populated. This reduces time loss during transport and is very useful when operating the machine in a flowline. An exit sub-stop, which can be seen as a transport buffer function, links the entrance sub-stop and main stopper, shortening the PCB transport time and reducing loss from inefficient operation.

When using the machine in a flowline, it communicates with the unit upstream and downstream over a SMEMA-connection.

Specifications	
PCB Dimensions (x,y):	Min. 50mm x 50mm (2.0" x 2.0")
	Max. 460mm x 440mm (18" x 17.2") using PCB pin fixation or PCB edge clamping system
PCB Thickness:	Min. 0.4mm (0.015")
	Max. 4.0mm (0.15")
Reference hole position:	5mm (0.2") in X and Y from lower right corner
Reference hole diameter:	Ø 2.0mm-Ø 4.0mm (0.08" - 0.157")
PCB Maximum warpage:	0.5mm up (0.02") 1.0mm down (0.04")
Max. height pre-mounted components:	4mm on placement side (0.16") 18mm on non placement side (0.7")
Non-Mountable area:	Board Top side: 3mm from rear side board edge (0.12") 0mm from front side board edge (Component height restrictions apply in the 10mm (0.40") area from front side edge depending on board thickness) 4mm around reference holes (0.16") (locate pins)
	Board Bottom side: 5mm from front and rear side board edge (0.2")
PCB Material:	Phenolic/FR4/Composite Materials Ceramic PCB transport is optional
PCB weight:	Max. 1.2 Kg without components Max. 2.0 Kg with components
PCB positioning:	Locate pin fixation (adjustable second pin) Z servo controlled push up system (software controlled by PCB thickness) Push up pins (adjustable positions) Edge clamping (with adjustable push in) Sub stop (PCB waiting buffer) adjustable position Exit stop (fixed position)
PCB Transport height:	900mm ± 10mm (35.4" ± 0.4") SMEMA 953mm ± 12.5mm (37.5" ± 0.5")
PCB Transport direction:	Left to Right standard, optional Right to Left
PCB Transport width:	Automatic
PCB loading time:	Approximately 3 sec.
PCB ratio width/length:	Max. 1:3

Table 7

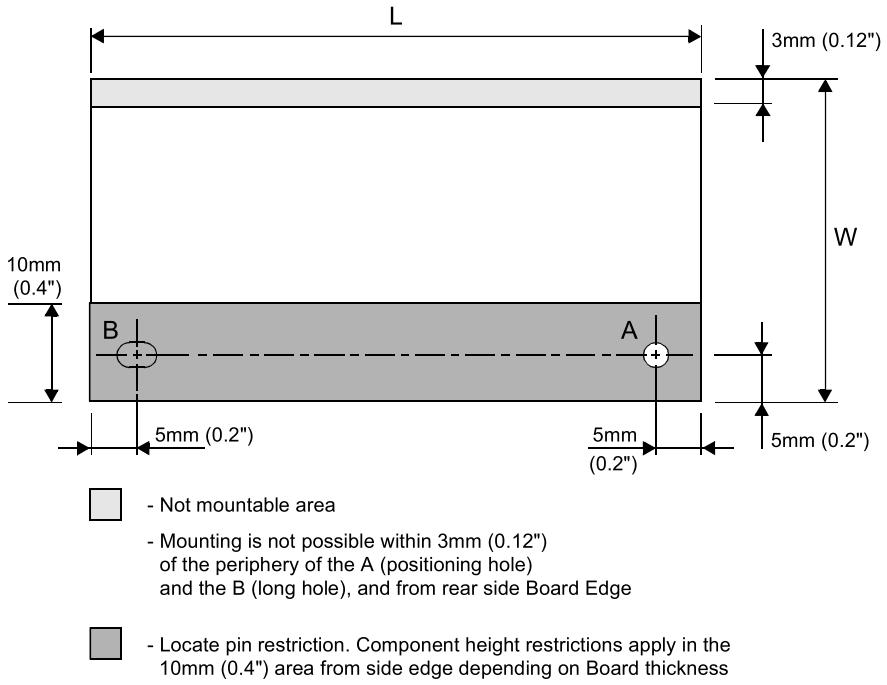


Figure 13 *Mountable area.*

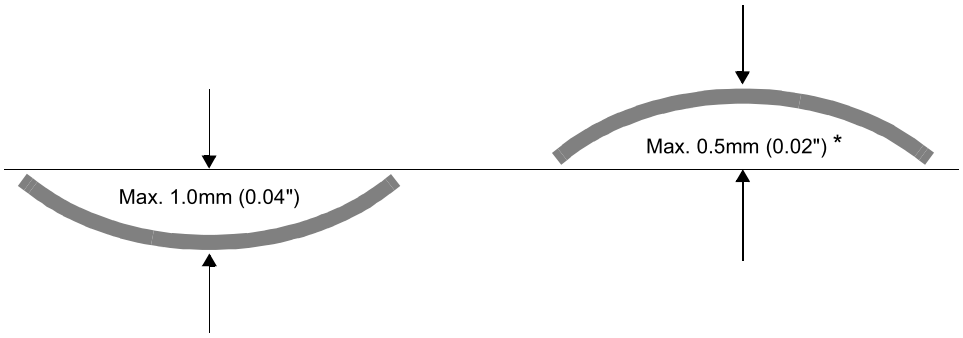


Figure 14 *Warp of fixed PCB.*

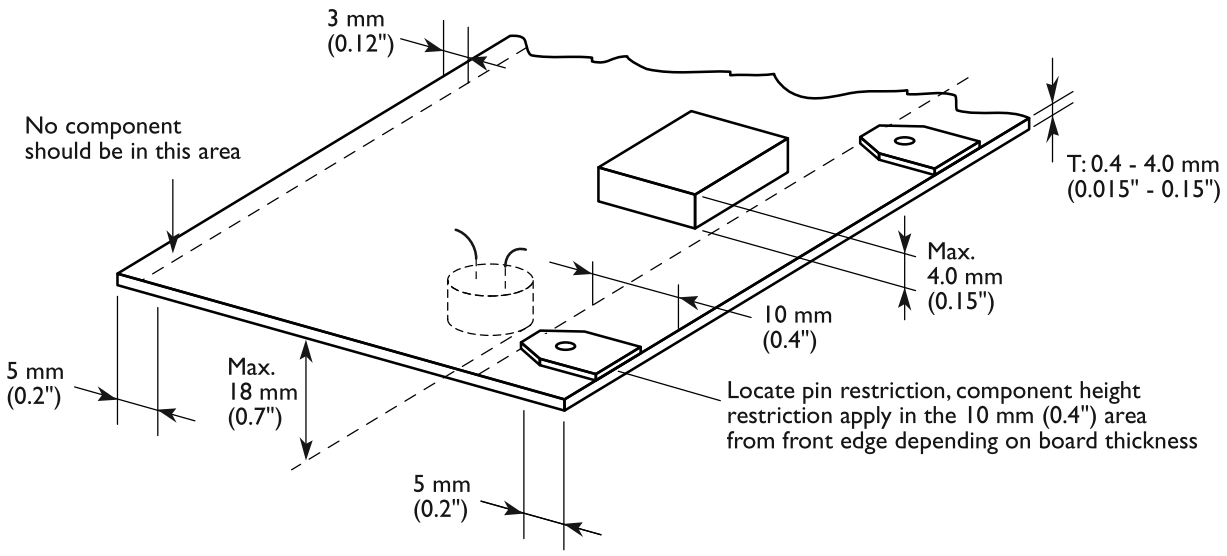


Figure 15 Mountable area.

7.0 Component Handling

7.1 Tape feeding

The GEM Topaz-X has a fully compatible feeder platform with all GemLine machines, Sapphire, Topaz, Emerald, and Emerald-X. Depending on the machine configuration up to 90 feeders (8mm) can be loaded.
The tape feeder design for the GemLine allows simultaneous picking from any mix of tape feeders ranging from 8 to 44mm. To achieve high speed feeding all feeder types are air driven. To prevent incorrect feeder latching, a laser-based verification system is used.

Available tape feeders		
Tape Feeder	**Feeding pitch (mm)**	**PA#**
Tape Feeder 8mm 7" for 0603 (0201) component (PSA)	2	PA 2903/73
Tape Feeder 8mm 7" for 1005 (0402)	2, 4	PA 2903/74
Tape Feeder 8mm 7" (PSA)	4	PA 2903/75
Tape Feeder 8mm 15" (PSA)	4	PA 2903/76
Tape Feeder 12mm 7" (PSA)	4, 8	PA 2903/85
Tape Feeder 12mm 15" (PSA)	4, 8	PA 2903/86
Tape Feeder 16mm 15"	4, 8, 12, 16	PA 2903/20
Tape Feeder 16mm 15" (PSA)	4, 8, 12, 16	PA 2903/25
Tape Feeder 24mm 15"	4, 8, 12, 16, 20	PA 2903/30
Tape Feeder 24mm 15" (PSA)	4, 8, 12, 16, 20	PA 2903/35
Tape Feeder 32mm 15"	12, 16, 24, 32	PA 2903/40
Tape Feeder 32mm 15" (PSA)	12, 16, 24, 32	PA 2903/45
Tape Feeder 44mm 15"	12, 16, 24, 32	PA 2903/50
Tape Feeder 44mm 15" (PSA)	12, 16, 24, 32	PA 2903/55

Table 8 *The feeding pitch can be adjusted on the feeder side.*

Feeder occupation	
Feeder type	**Required feeder position equivalent to tape feeder 8mm**
Tape Feeder 8mm	1
Tape Feeder 12mm, 16mm, 24mm	3
Tape Feeder 32mm	4
Tape Feeder 44mm	5

Table 9 *The above feeder conversion number may differ according to the installation combination.*

For larger and special tape feeders such as 56mm, 72mm please contact your local sales representative

7.2 Double Shuttle Tray Feeder (PA 2699/22)

The double shuttle Tray feeder is an additional pallet sequencer feeding parts from a tray. This feeder can be equipped with maximum 40 pallets, each being able to hold different trays.

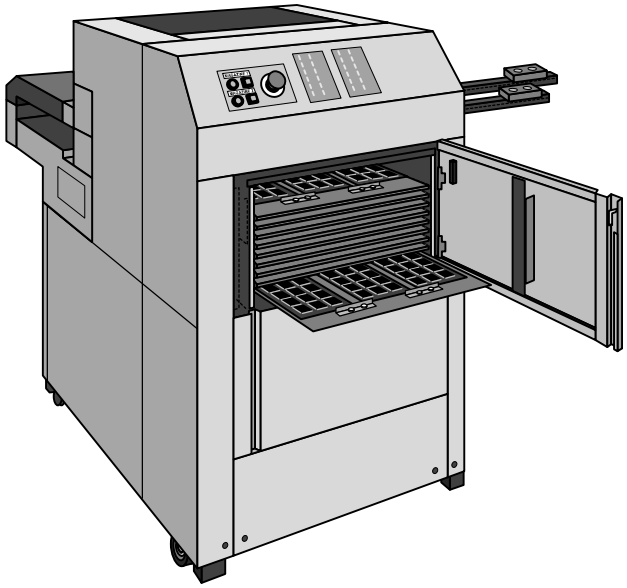


Figure 16 *Double shuttle Tray Feeder.*

Two components are picked up from the tray with a double head, and placed simultaneously on a shuttle. This shuttle then moves into the machine where the components are picked by the placement head. The part is then aligned by vision and placed on the PCB. At the same moment when the components are picked by the placement head a second shuttle will be supplied with the next components which minimize the feeding time.

The component feeding time of the double shuttle Tray feeder is 3.5 seconds for 2 parts when using the same tray (pallet 1) and 8.5 seconds when changing the tray (pallet 40). However, in practice no time is lost because of the simultaneous operation of Tray sequencer and Topaz-X: while the machine is picking from on-board feeders, the shuttle brings in new components. A part that is rejected by vision will be placed back on the reject conveyor which means no loss of expensive parts.

The PCB conveyor on the double shuttle Tray feeder offers the possibility for visual PCB inspection.

- A tray container is fixed and separated into two sections with each 20 pallets. This allows tray replenishment while the machine is running.

- A buffer conveyor is standard equipped, so a reflow oven can be connected without additional conveyors.

LCS Tray Feeder specifications	
GENERAL	
Max. Tray size (L x W):	350mm x 468mm (13.7" x 18.4"); which can hold 3 Jedec trays
Min. Tray size (L x W):	50mm x 50mm (2.0" x 2.0")
Component feeding time	3.5 sec. for 2 parts (picking from pallet 1) 8.5 sec. for 2 parts (picking one from pallet 1 and one from pallet 40)
Power and air supply:	Delivered by Topaz-X
LCS Tray feeder dimensions:	Length: 826mm (2.8 ft) Height: 1165mm (3.8 ft); with top cover open 1545mm (5.2 ft) Width: 1650mm (5.2 ft); with door open 2292mm (7.6 ft)
Topaz-X + Tray feeder dimensions:	Length: 2476mm (8.3 ft) Height: 1850mm (6.1 ft) Width: 1842mm (6.1 ft); with LCS door open and feeders on Topaz-X 2942mm (9.8 ft)
Weight:	± 280 kg (617 Lbs)
Power supply, air supply	Supplied from main machine
APPLICABLE COMPONENTS	
Min. Component dimension:	8mm x 8mm (0.31" x 0.31") Mold size
Max. Component dimension:	45mm x 45mm (1.8" x 1.8")
Max. Tray height included component height:	8.5mm (0.33") from pallets at pitch of 12.5mm (0.5"), total 40 pallets possible
	20mm (0.78") from pallets at pitch of 25mm (0.98"), total 20 pallets possible
FEED CAPACITY	
Number of shuttles:	2
Number of pads on each shuttle:	2 (with a pitch of 48mm)
STANDARD COMPONENT CAPACITY	
Max. number of component types:	120 (3 x 40 Jedec)
Number of pallets:	Standard 30 pallets included (additional pallets available PA 2981/15)

Table 10

7.3 ATS 20 Tray Feeder portrait (PA 2696/21)

The ATS 20 Tray Feeder is a new additional internal pallet sequencer, allowing high-speed feeding of tray components. This feeder can be equipped with a maximum of 20 pallets, each being able to hold different trays.

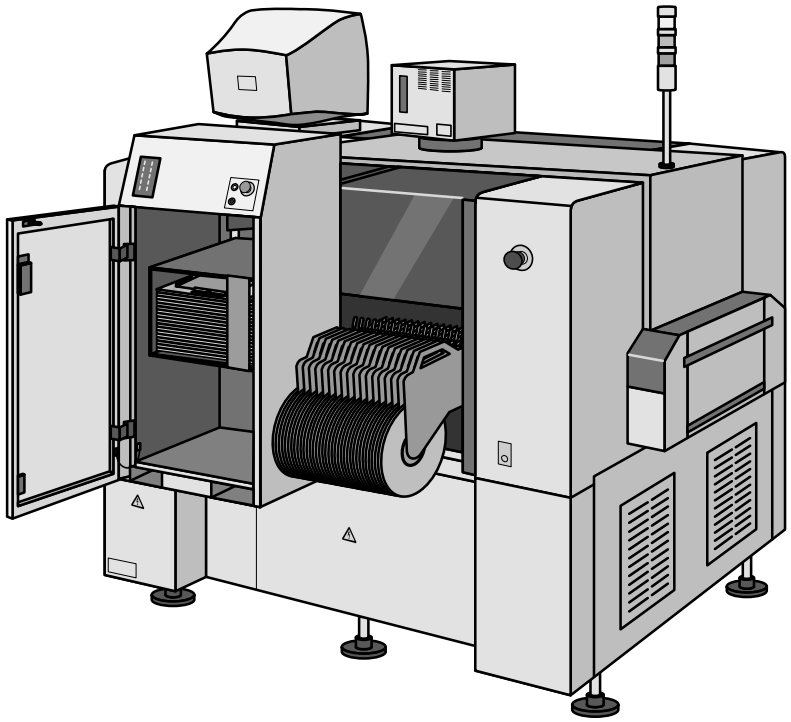


Figure 17 *ATS 20 Tray Feeder portrait.*

The maximum pallet exchange time for the ATS 20 Tray feeder is 5.6 seconds. However, in practice no time is lost because of the simultaneous operation of the ATS 20 Tray feeder and Topaz-X; while the machine is picking from on-board feeders, the pallet brings in new components.

A part rejected by vision will be placed back in its original tray position; this means no loss of expensive parts.

ATS 20 Tray Feeder portrait (PA 2696/21) specifications	
GENERAL	
Max. Tray size (L x W):	220mm x 350mm (8.6" x 13.7").
Min. Tray size (L x W):	50mm x 50mm (2.0" x 2.0")
Pallet exchange time:	Changing from pallet 1 to 20; 5.6 seconds
Weight:	± 80 Kg (176 Lbs)
Power and air supply:	Supplied by Topaz-X.
Topaz-X + ATS 20 Tray feeder dimensions:	Length: 1650mm (5.5 ft) Height: 1850mm (6.2 ft) Width: 1870mm (6.2 ft); with ATS 20 door open: 2220mm (7.4 ft)
Maximum board size Topaz-X:	250mm (9.8")
Maximum amount of feeders on Topaz-X:	60
APPLICABLE COMPONENTS	
Max. Tray height included component height:	8.5mm (0.33") from pallets at pitch of 12.5mm (0.49"); total 20 pallets possible.
	16mm (0.63") from pallets at pitch of 25mm (0.98"); total 10 pallets possible.
Min. Component dimension:	6mm x 6mm (0.24" x 0.24") mold size
Max. Component dimension:	32mm x 32mm (1.3" x 1.3")
STANDARD COMPONENT CAPACITY	
Max. number of component types:	20 (20 × 1 Jedec tray)
Number of pallets:	Standard 20 pallets included (additional pallets available PA 2981/35)

Table 11

7.4 Double ATS 20 Tray Feeder portrait (PA 2696/22)

The Double ATS 20 Tray Feeder portrait is a new additional internal pallet sequencer, allowing high-speed feeding of tray components. This feeder can be equipped with a maximum of 2 x 20 pallets, each being able to hold different trays.

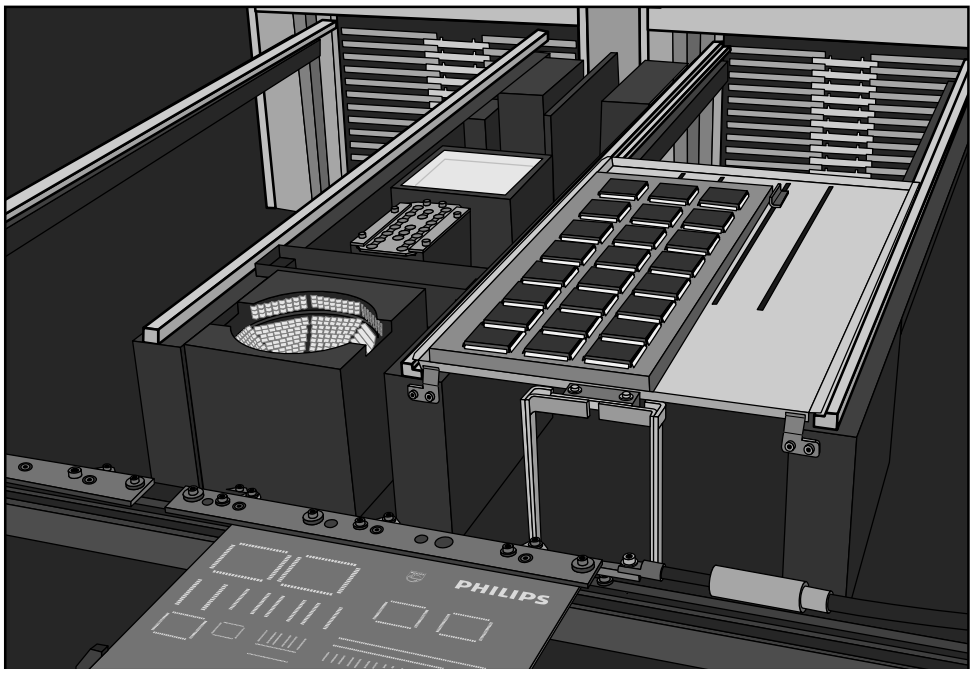


Figure 18 *Double ATS 20 Tray Feeder portrait.*

The maximum pallet exchange time for the Double ATS 20 Tray feeder is 5.6 seconds. However, in practice no time is lost because of the simultaneous operation of the Double ATS 20 Tray feeder and Topaz-X; while the machine is picking from on-board feeders, the pallet brings in new components.

A part rejected by vision will be placed back in its original tray position; this means no loss of expensive parts.

Double ATS 20 Tray Feeder portrait (PA 2696/22) specifications	
GENERAL	
Max. Tray size (L x W):	220mm x 350mm (8.6" x 13.7").
Min. Tray size (L x W):	50mm x 50mm (2.0" x 2.0")
Pallet exchange time:	Changing from pallet 1 to 20; 5.6 seconds
Pick up restrictions:	At the left ATS 20 components can't be picked by all heads in an area of 36mm (1.4")from the left side of the pallet.
Power and air supply:	Supplied by Topaz-X.
Weight:	± 160 Kg (342 Lbs)
Topaz-X + double ATS 20 Tray feeder dimensions:	Length: 1650mm (5.5 ft) Height: 1850mm (6.2 ft) Width: 1870mm (6.2 ft); with ATS 20 door open: 2220mm (7.4 ft)
Maximum board size Topaz-X:	250mm (9.8")
Maximum amount of feeders on Topaz-X:	40
APPLICABLE COMPONENTS	
Max. Tray height included component height:	8.5mm (0.33") from pallets at pitch of 12.5mm (0.49"); total 20 pallets possible.
	16mm (0.63") from pallets at pitch of 25mm (0.98"); total 10 pallets possible.
Min. Component dimension:	6mm x 6mm (0.24" x 0.24") mold size
Max. Component dimension:	32mm x 32mm (1.3" x 1.3")
STANDARD COMPONENT CAPACITY	
Max. number of component types	40 (40 × 1 Jedec tray)
Number of pallets:	Standard 2 x 20 pallets included (additional pallets available PA 2981/35)

Table 12

7.5 ATS 20 Tray Feeder landscape (PA 2696/23)

The ATS 20 Tray Feeder landscape is a new additional internal pallet sequencer, allowing high-speed feeding of tray components. This feeder can be equipped with a maximum of 20 pallets, each being able to hold different trays.

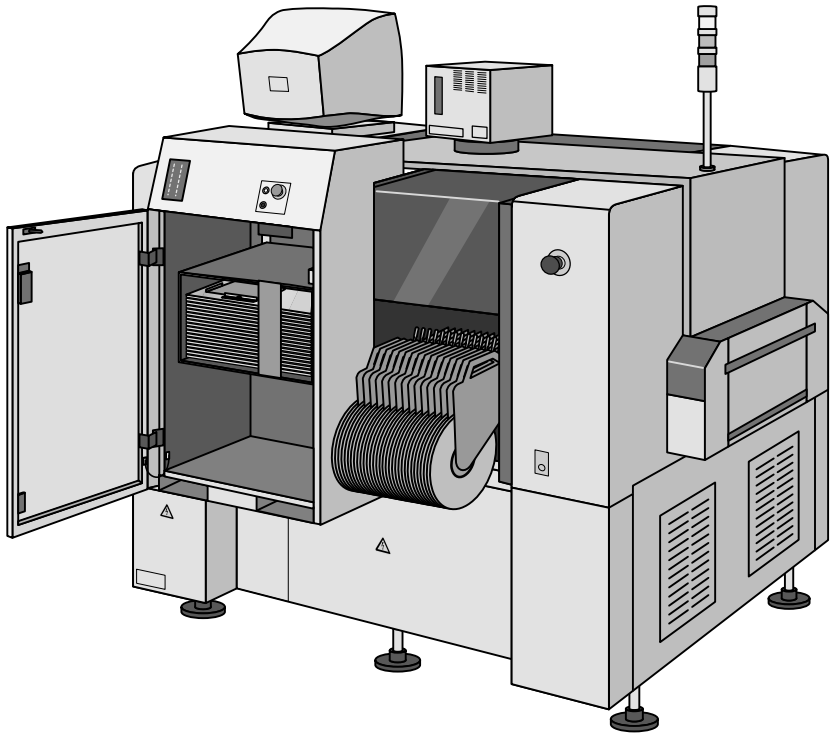


Figure 19 *ATS 20 Tray Feeder landscape.*

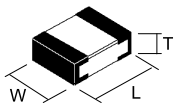
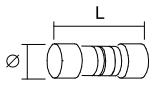
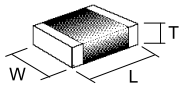
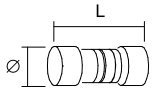
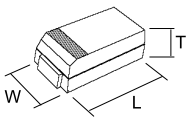
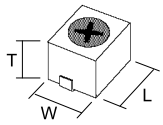
The maximum pallet exchange time for the ATS 20 Tray Feeder landscape is 5.6 seconds. However, in practice no time is lost because of the simultaneous operation of the ATS 20 Tray Feeder landscape and Topaz-X; while the machine is picking from on-board feeders, the pallet brings in new components.

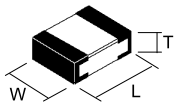
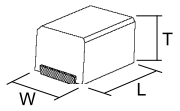
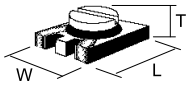
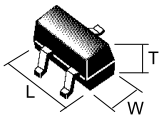
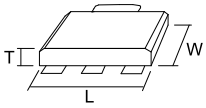
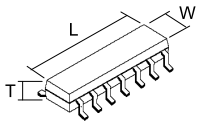
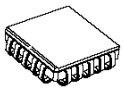
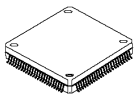
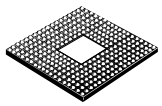
A part rejected by vision will be placed back in its original tray position; this means no loss of expensive parts.

ATS 20 Tray Feeder landscape (PA 2696/23) specifications	
GENERAL	
Max. Tray size (L x W):	350mm x 220mm (13.7" x 8.6").
Min. Tray size (L x W):	50mm x 50mm (2.0" x 2.0")
Pallet exchange time:	Changing from pallet 1 to 20; 5.6 seconds
Pick up restrictions:	At the right side of the ATS 20 landscape pallet components can't be picked by all heads in an area of 18.2mm (0.72").
Power and air supply:	Supplied by Topaz-X.
Weight:	± 80 Kg (176 Lbs)
Topaz-X + Landscape ATS 20 Tray feeder dimensions:	Length: 1650mm (5.5 ft) Height: 1850mm (6.2 ft) Width: 1783mm (5.9 ft); with ATS 20 door open: 2283mm (7.6 ft)
Maximum board size Topaz-X:	380mm (15.0")
Maximum amount of feeders on Topaz-X:	56
APPLICABLE COMPONENTS	
Max. Tray height included component height:	8.5mm (0.33") from pallets at pitch of 12.5mm (0.49"); total 20 pallets possible.
	16mm (0.63") from pallets at pitch of 25mm (0.98"); total 10 pallets possible.
Min. Component dimension:	6mm x 6mm (0.24" x 0.24") mold size
Max. Component dimension:	32mm x 32mm (1.3" x 1.3")
STANDARD COMPONENT CAPACITY	
Max. number of component types:	20 (20 × 1 Jedec tray)
Number of pallets:	Standard 2 x 20 pallets included (additional pallets available PA 2981/36)

7.6 Mountable Components & Required Nozzles GEM Topaz-X

Just five nozzle shapes are required to cover the specified SMD range. High output levels are therefore achieved, as the need for nozzle exchanges is minimal. An optional 18 position nozzle exchange station enables additional special nozzles to be accommodated.

Components		Dimension (mm)			Required nozzle
		L	W	T	
	Solid resistor	0.60	0.30	0.25	Type 71A/71F
		1.00	0.50	0.50	Type 71A/71F
		1.60	0.80	0.50	Type 72A/72F
		2.00	1.25	0.50	Type 72A/72F
		3.20	1.60	0.60	Type 72A/72F
	Solid resistor	2.00	ø 1.25		Type 72A/72F
		3.45	ø 1.35		Type 72A/72F
		5.9	ø 2.2		Type 72A/72F
	Multi-Layered ceramic capacitor	0.6	0.3	0.3	Type 71A/71F
		1.0	0.5	0.5	Type 71A/71F
		1.50	0.80	0.80	Type 72A/72F
		2.00	1.25	1.25	Type 72A/72F
		3.20	1.60	1.25	Type 72A/72F
		3.20~4.50	2.50~3.20	1.50~1.90	Type 73A/73F
		5.60	5.00	1.90	Type 73A/73F
	MELF ceramic capacitor	3.40	ø 1.50		Type 72A/72F
		5.9	ø 2.2		Type 76A
	Tantalium electrolytic capacitor	2.90	1.60	1.60	Type 72A/72F
		3.80	2.90	1.60	Type 73A/73F
		4.70	2.60	2.10	Type 73A/73F
		6.00	3.20	2.50	Type 73A/73F
		7.30	4.30	2.80	Type 73A/73F
	Aluminium electrolytic capacitor	4.3	4.3	5.7	Type 73A/73F
		6.6	6.6	5.7	Type 73A/73F
		10	10	10.5	Type 74A

Components		Dimension (mm)			Required nozzle
		L	W	T	
	Chip film capacitor	7.3	5.3	3.25	Type 73A/73F
	Chip inductor	3.2	2.5	2.0	Type 73A/73F
		4.5	3.2	3.2	Type 73A/73F
	Semi-variable resistor	4.5	3.8	2.4	Type 73A/73F
	Transistor (SOT)	2.90	1.5	1.10	Type 72A/72F
		4.0	3	1.8	Type 73A/73F
	Power transistor	4.6	2.6	1.6	Type 73A/73F
	SOP (6 ~ 28 pin)	5.00	4.50	1.50	Type 73A/73F
		7.60	4.50	1.50	Type 73A/73F
		10.10	4.50	1.50	Type 73A/73F
		12.60	5.70	1.50	Type 73A/73F
		15.30	7.50	2.00	Type 74A
		17.80	7.50	2.00	Type 74A
	PLCC	⍁ 5~16			Type 73A/73F
		⍁ 15~20			Type 74A
		⍁ 15~32			Type 74A
	QFP	⍁ 5~16			Type 74A
		⍁ 15~20			Type 74A
		⍁ 15~32			Type 74A
	BGA	⍁ 10~26			Type 74A
		⍁ 10~30			Type 74A

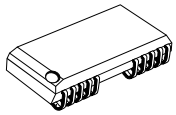
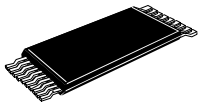
Components		Dimension (mm)			Required nozzle
		L	W	T	
	SOJ (20 ~ 42 pin)	☑ 10~20 ☑ 15~30			Type 73A/73F Type 74A
	TSOP (20 ~ 32 pin)	☑ 10~20 ☑ 15~30			Type 73A/73F Type 74A

Table 13 *For information on CSP, µBGA, bare chip and other types of components, please consult your local sales representative.*