



Content

1	Introduction	1
1.1	FACS Configuration System	1
1.2	MEL-FACS Hardware Architecture	3
1.3	MEL-FACS Software Functionality	4
1.3.1.	Device Integration and Adding Functionality	4
2	Assembly Process Description	5
2.1	Task Based Assembly Process	5
2.2	Basic Program Flowchart	5
2.3	Tasks Type	7
2.4	Tasks Status Codes	7
2.5	Station Prerequisite Management	8
2.6	Model Management	9
2.7	Station Types	10
2.7.1.	“Continuous Moving” Assembly Line	10
2.7.2.	“Stop-In-Station” Assembly Line	12
2.8	“Dual GOT” on either side of the Assembly Line	14
2.9	Multi-Foot Print Stations	15
2.10	Task Sequencing Management	16
2.11	Workpiece Re-Run Management	17
2.12	Task Bypass Management	17
2.13	“Workpiece Reject” Management	17
2.14	“Workpiece Release” Management	18

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1 Introduction

This document describes the overview of an assembly process and the FACS system (“Flexible Assembly Configuration System”) that is used in the process. The FACS system defines a standardized control concept for assembly line operations.

The main components of a FACS system include:

- an assembly system configuration system, eFACS – provided by eFlex Systems
- a standardized assembly station hardware architecture, and
- a standardized assembly station PLC control logic – MEL-FACS Library – provided by MEAU

The assembly station operations and tasks are configured by means of a configuration system instead of being programmed individually.

Each assembly station is based on standardized hardware architecture, which is capable of controlling all devices required for the predefined task types. Figure 1 illustrates a typical assembly line with FACS system with FACS configuration server and workstation connecting to the manual work station PLC’s on the line.

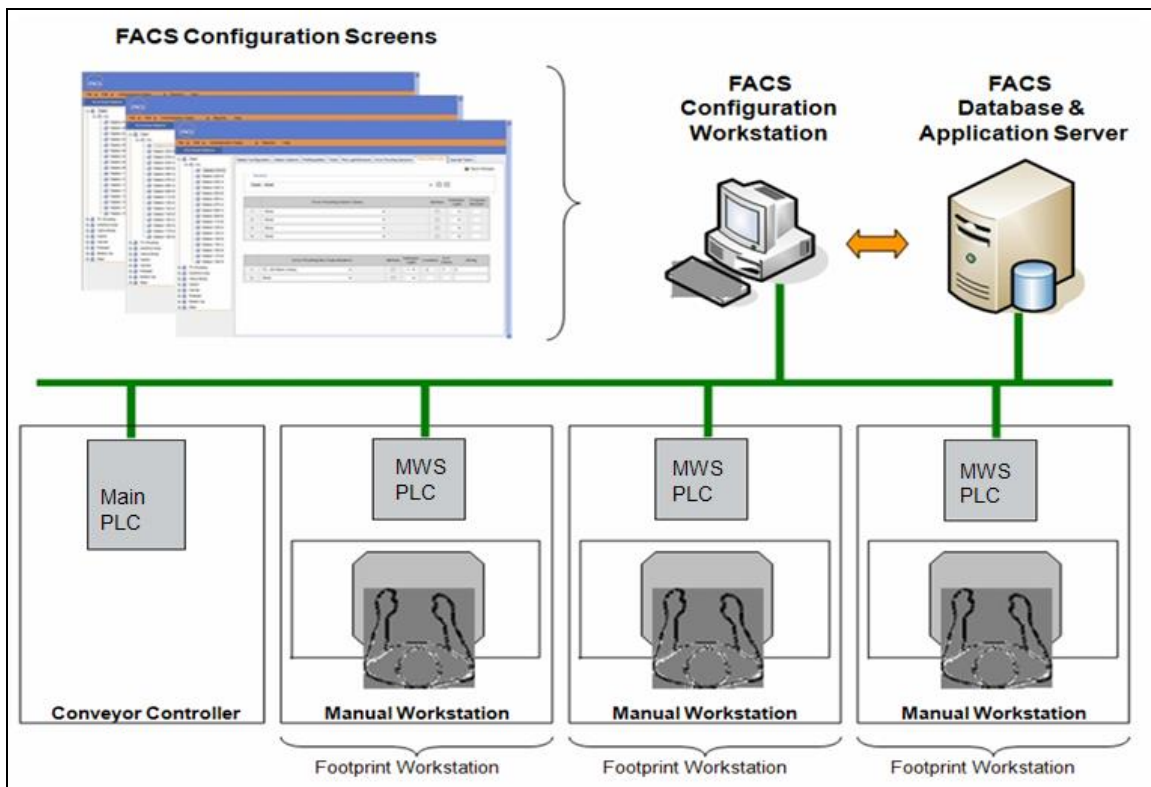


Figure 1 FACS Overall System Architecture

1.1 FACS Configuration System

A “FACS Configuration System” is used to configure the assembly station control logic. The configuration parameters include:

- Configuration of station operations
- Configuration of station tasks
- Build matrix configuration
- Prerequisite configuration
- Task sequencing configuration

Mitsubishi Electric MEL-FACS – Part 1: FACS and Assembly Process Overview

The assembly station configuration parameters are downloaded to the individual stations by means of a communication network. All configuration parameters are stored in the station controller (PLC) and then executed by the standard function blocks in the PLC as shown in Figure 2.

The details of Mitsubishi MEL-FACS hardware and software architectures are described in Part 2 of the Mitsubishi Electric MEL-FACS Manuals.

Note:

The FACS configuration system is only required to configure the assembly stations. The assembly stations control logic does not require an online connection with the configuration system in order to control the process.

However, status information can be sent to the FACS configuration system as long as the configuration system maintains a connection with the station controller and the status upload capability is enabled.

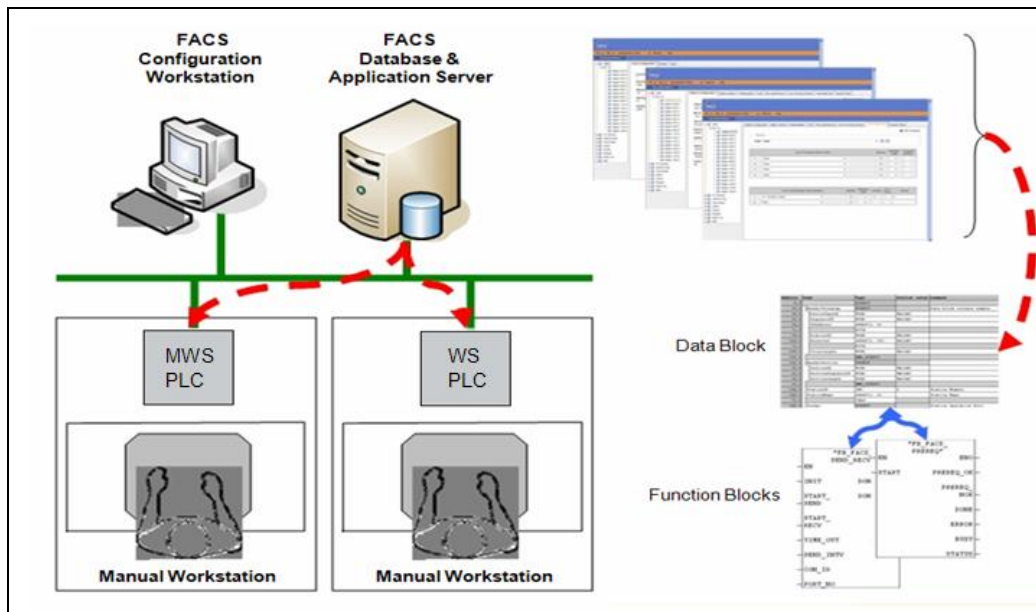


Figure 2 Flexible Assembly Configuration System Operation

The FACS Configuration system is a server-based system that is capable of configuring a large number of manual work stations on an assembly line.

Note:

eFlex Systems provides a configuration system that has been verified with the MEL-FACS system.

eFlex Systems

210 W. Tienken Rd

Rochester, MI 48306 (USA)

Phone: (248) 651-5979

<http://www.eFlexSystem.com>

1.2 MEL-FACS Hardware Architecture

The Mitsubishi MEL-FACS hardware architecture is based on the MELSEC iQ series PLC/Modules.

The MEL-FACS Hardware architecture is shown as below.

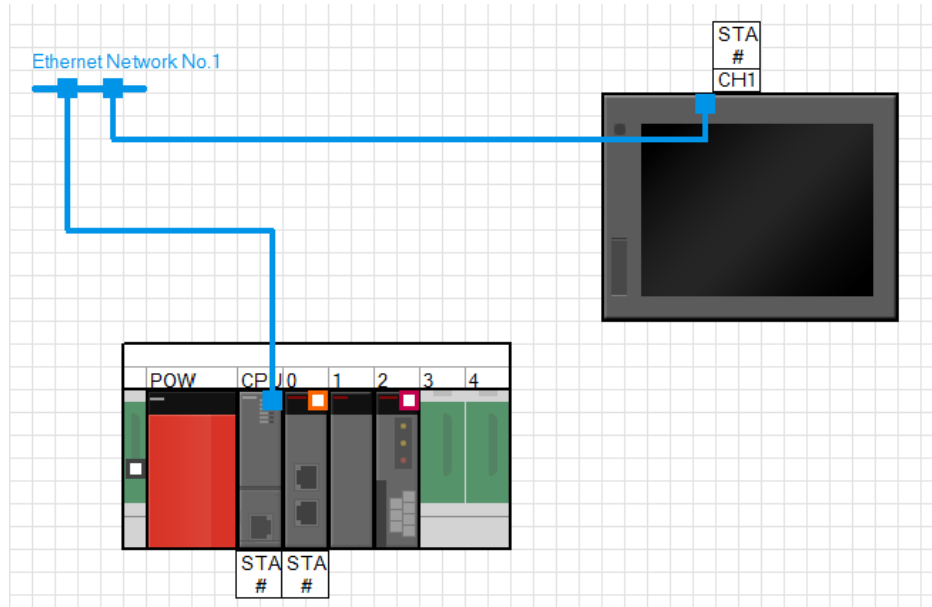
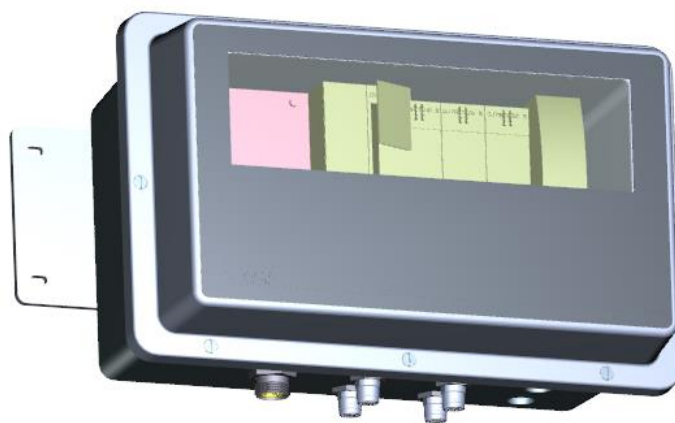


Figure 3 Manual Workstation Control

An example of manual workstation for control system consists of following components

- iQ Series PLC system, includes base rack, power supply, PLC with Built-in Ethernet port, Fieldbus Master module, Input module and Output module and RFID Module based on the Customer specification.

The MEL-FACS typical IP 67 enclosure is shown below



Note:

The hardware configuration and enclosure style may vary based on customer's specification.

1.3 MEL-FACS Software Functionality

The Mitsubishi MEL-FACS contains a software library which provides a complete framework for a typical assembly line manual workstation.

The functionality features of the software library include:

- Support for “stop in station” assembly line concepts
- Support of pre stop areas for “stop in station assembly” lines
- Support of “Dual-GOT” – two GOT’s on either side of the Assembly Line station
- Support of Multi-Foot Print stations – Multiple Work Stations share single PLC and GOT
- Handling of part reject
- Handling of station and task bypass configuration
- Model specific build data (up to 200 build configuration)
- Direct control of all sensors and actuators connected via physical I/O channels
- Managing of RFID systems in different configurations
- Support for typical assembly tools (e.g. error proofing sensors, stitching and multi spindle controller, vision systems and barcode reader)
- Support of indicator lights in different configurations
- Standard sequencing of a typical assembly station operations (e.g. read RFID, determine prerequisites, lookup model build data, enable tools and operations, write RFID)

1.3.1. Device Integration and Adding Functionality

The Mitsubishi MEL-FACS software library also controls all devices which are connected via physical I/O channels to the MEL-FACS control system.

All other devices (e.g. vision systems, multi spindle controller) have to be integrated by means of additional user application. The software library provides standard data interfaces for these devices with predefined parameter input and output areas.

The software library function blocks are sequenced by means function block input and output parameters. The standard sequence of function block is capable to control a typical manual workstation. It is possible to integrate additional functionality in order to control “special purpose” assembly stations (e.g. pallet load or unload station) or manual workstations with additional assembly devices. The interlocking (sequencing) of the operations is open to the user application.

2 Assembly Process Description

2.1 Task Based Assembly Process

The Mitsubishi MEL-FACS software library implements a task based controls concept. The entire assembly process is subdivided into individual tasks (e.g. error proofing task, pick sensor task).

Each task is identified by a unique number which represents the RFID tag address in which the task status is stored.

The tasks are assigned to the individual assembly line stations via a FACS configuration system.

Every assembly line station is capable to perform a predefined number of tasks by means of standard PLC logic.

2.2 Basic Program Flowchart

The basic program flowchart of the Mitsubishi MEL-FACS is shown in the following figure.

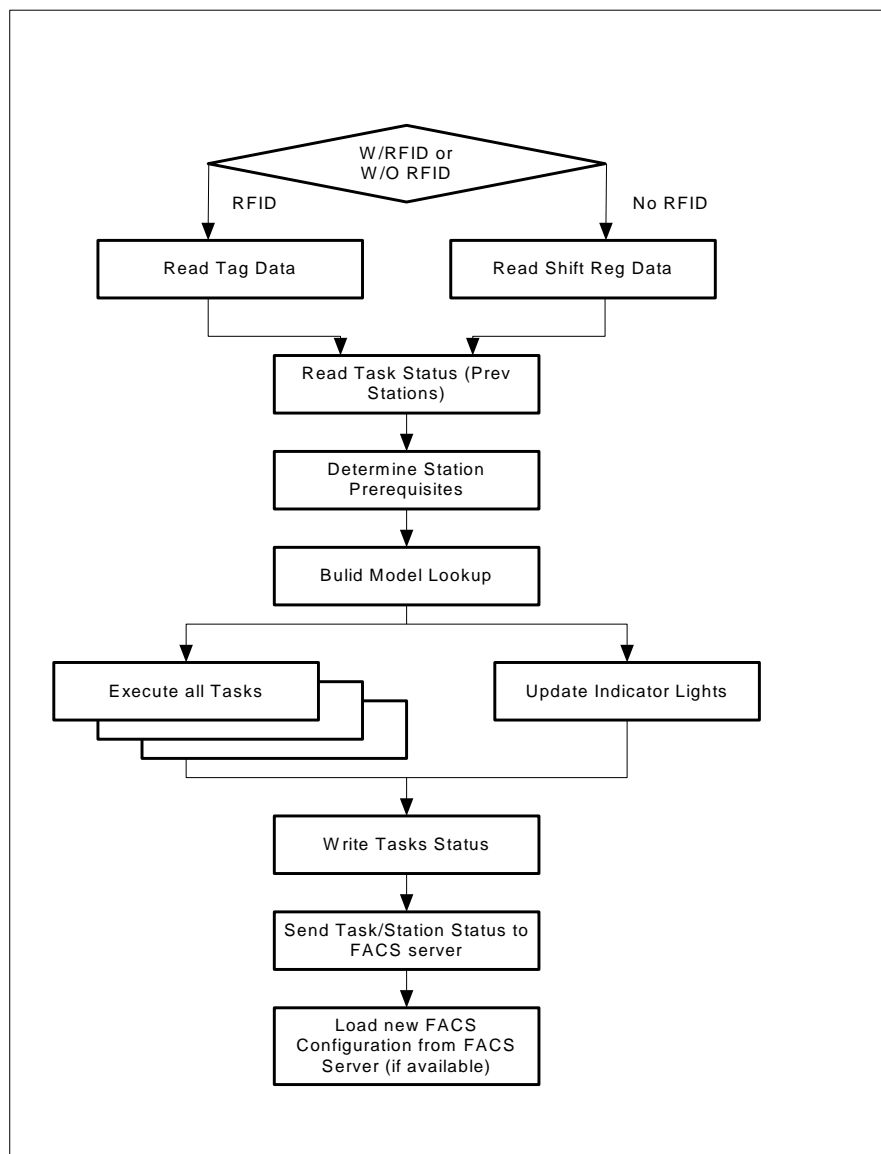


Figure 4 Basic Program Flow Chart

The process starts as soon as a new workpiece enters the assembly station. A new workpiece can be detected by either a proximity switch or an encoder system.

1. Read Task status

All task statuses are stored on an RFID tag. The read operation is executed at the entrance of the assembly station (see “Continuous Moving Line”), at the pallet pre-stop position or in the station (see “Stop In Station Line”). The complete defined RFID tag memory area is read and stored in a local memory buffer in the PLC (data block) for further processing.

2. Determine Station Prerequisites

Station prerequisites are defined as tasks, which have to be completed with an “accepted” status. The tasks assigned to an assembly station are only activated if the station prerequisites are fulfilled. All tasks are assigned the status “Prerequisite(s) not met” if the prerequisites are not fulfilled.

3. Read Global Status

Global status determines whether or not the workpiece is workable.

4. Read Model Specific Task Parameter

Up to 200 different model specific build data can be configured. The required build data set is determined based on the part identification code stored on the RFID tag. The build data are processed by the station tasks.

5. Execute/Monitor Tasks

During this process the different tasks are activated if the following requirements are fulfilled:

- Prerequisites are fulfilled and workpiece is workable
- Station is not bypassed
- Task is not bypassed
- Task enabled for the specific model

All tasks produce result codes on completion (see “Task Status Codes”). The result codes are tracked and stored in a local memory buffer in the PLC.

Continuous Moving Line

The conveyor will be stopped if a task did not report an “accepted” status code within the available tool work footprint area. The conveyor will be resumed if the operator rejects the workpiece.

Stop In Station Assembly Line

A pallet can only be released if all tasks reported an “accepted” status code or if the operator rejects the workpiece.

6. Write Task status

The stored task status results are written to the RFID tag before the workpiece leaves the station. The write operation is executed at the exit of the station (see “Continuous Moving Line”) or in the station (see “Stop In Station Line”).

7. Send Task/Station Status

The task and status information are sent to the FACS configuration for backup.

8. Load New Configuration Data

The configuration data are stored in File Registers (ZR registers) in the PLC. New configuration can be downloaded from the FACS configuration server to the station controller via an Ethernet network connection. The data are loaded into the configuration registers (activated) only after the current active workpiece is completed.

2.3 Tasks Type

The assembly process tasks are differentiated by tasks types. The following table lists the predefined task types and the quantity of task which can be assigned to a typical single assembly station. The task types and the quantity of task may vary based on the customer/OEM requirements.

Task Type	Max Number of Tasks for Manual Station	Max Number of Tasks for Auto Station
Stitching Tool	8	8
Stitching Tool as Backup	2 x 32 (Sub)	2 x 32 (Sub)
Stitching Tool w/Socket Tray	8 x 8 (Sub)	8 x 8 (Sub)
Multi-Spindle Tools	4 x 32 (Sub)	4 x 32 (Sub)
Pick Lights and Sensors	16 (32 I/O Points)	16 (32 I/O Points)
Error Proofing Sensors	16	16
Vision system error proofing	4 x 16 (Sub)	10 x 16 (Sub)
Bar Code Readers	2 x 10 (Sub)	2 x 10 (Sub)
Test	4 x 8 (Sub)	8 x 8 (Sub)
Press	4	8
Lubrication	8	8
Robot/Servo	4	4
Generic Backup	2	2
Universal	4	4

The additional task type “Station task” represents a summary of all tasks assigned to a single station. A maximum of one “Station task” can be assigned to a station. The “Station Task” can be referenced by subsequent stations as part of the prerequisite conditions.

2.4 Tasks Status Codes

The status of the tasks is tracked throughout the assembly system by means of task status codes. The following table lists all defined task status codes.

Task Statuses														
Click for Index														
Task Type	<div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div> <div>Station Multi-spindle (controller) Multi-spindle (spindle) All other task types</div>													
Diagnostic Status														
Station	00	01	02	03	04	05	06	07	08	09	10	11	12	13
Multi-spindle (controller)	14	15	16	17	18	19	20	21	22	23	24	25	26	27
Multi-spindle (spindle)	28	29	30	31	32	33	34	35	36	37	38	39	40	41
All other task types	42	43	44	45	46	47	48	49	50	51	52	53	54	55
Station	56	57	58	59	60	61	62	63	64	65	66	67	68	69
Multi-spindle (controller)	70	71	72	73	74	75	76	77	78	79	80	81	82	83
Multi-spindle (spindle)	84	85	86	87	88	89	90	91	92	93	94	95	96	97
All other task types	98	99	100	101	102	103	104	105	106	107	108	109	110	111
Station	112	113	114	115	116	117	118	119	120	121	122	123	124	125
Multi-spindle (controller)	126	127	128	129	130	131	132	133	134	135	136	137	138	139
Multi-spindle (spindle)	140	141	142	143	144	145	146	147	148	149	150	151	152	153
All other task types	154	155	156	157	158	159	160	161	162	163	164	165	166	167
Station	168	169	170	171	172	173	174	175	176	177	178	179	180	181
Multi-spindle (controller)	182	183	184	185	186	187	188	189	190	191	192	193	194	195
Multi-spindle (spindle)	196	197	198	199	200	201	202	203	204	205	206	207	208	209
All other task types	210	211	212	213	214	215	216	217	218	219	220	221	222	223
Station	224	225	226	227	228	229	230	231	232	233	234	235	236	237
Multi-spindle (controller)	238	239	240	241	242	243	244	245	246	247	248	249	250	251
Multi-spindle (spindle)	252	253	254	255	256	257	258	259	260	261	262	263	264	265
All other task types	266	267	268	269	270	271	272	273	274	275	276	277	278	279
Station	280	281	282	283	284	285	286	287	288	289	290	291	292	293
Multi-spindle (controller)	294	295	296	297	298	299	300	301	302	303	304	305	306	307
Multi-spindle (spindle)	308	309	310	311	312	313	314	315	316	317	318	319	320	321
All other task types	322	323	324	325	326	327	328	329	330	331	332	333	334	335
Station	336	337	338	339	340	341	342	343	344	345	346	347	348	349
Multi-spindle (controller)	350	351	352	353	354	355	356	357	358	359	360	361	362	363
Multi-spindle (spindle)	364	365	366	367	368	369	370	371	372	373	374	375	376	377
All other task types	378	379	380	381	382	383	384	385	386	387	388	389	390	391
Station	392	393	394	395	396	397	398	399	400	401	402	403	404	405
Multi-spindle (controller)	406	407	408	409	410	411	412	413	414	415	416	417	418	419
Multi-spindle (spindle)	420	421	422	423	424	425	426	427	428	429	430	431	432	433
All other task types	434	435	436	437	438	439	440	441	442	443	444	445	446	447
Station	448	449	450	451	452	453	454	455	456	457	458	459	460	461
Multi-spindle (controller)	462	463	464	465	466	467	468	469	470	471	472	473	474	475
Multi-spindle (spindle)	476	477	478	479	480	481	482	483	484	485	486	487	488	489
All other task types	490	491	492	493	494	495	496	497	498	499	500	501	502	503
Station	504	505	506	507	508	509	510	511	512	513	514	515	516	517
Multi-spindle (controller)	518	519	520	521	522	523	524	525	526	527	528	529	530	531
Multi-spindle (spindle)	532	533	534	535	536	537	538	539	540	541	542	543	544	545
All other task types	546	547	548	549	550	551	552	553	554	555	556	557	558	559
Station	560	561	562	563	564	565	566	567	568	569	570	571	572	573
Multi-spindle (controller)	574	575	576	577	578	579	580	581	582	583	584	585	586	587
Multi-spindle (spindle)	588	589	590	591	592	593	594	595	596	597	598	599	600	601
All other task types	602	603	604	605	606	607	608	609	610	611	612	613	614	615
Station	616	617	618	619	620	621	622	623	624	625	626	627	628	629
Multi-spindle (controller)	630	631	632	633	634	635	636	637	638	639	640	641	642	643
Multi-spindle (spindle)	644	645	646	647	648	649	650	651	652	653	654	655	656	657
All other task types	658	659	660	661	662	663	664	665	666	667	668	669	670	671
Station	672	673	674	675	676	677	678	679	680	681	682	683	684	685
Multi-spindle (controller)	686	687	688	689	690	691	692	693	694	695	696	697	698	699
Multi-spindle (spindle)	700	701	702	703	704	705	706	707	708	709	710	711	712	713
All other task types	714	715	716	717	718	719	720	721	722	723	724	725	726	727
Station	728	729	730	731	732	733	734	735	736	737	738	739	740	741
Multi-spindle (controller)	742	743	744	745	746	747	748	749	750	751	752	753	754	755
Multi-spindle (spindle)	756	757	758	759	760	761	762	763	764	765	766	767	768	769
All other task types	770	771	772	773	774	775	776	777	778	779	780	781	782	783
Station	784	785	786	787	788	789	790	791	792	793	794	795	796	797
Multi-spindle (controller)	798	799	800	801	802	803	804	805	806	807	808	809	810	811
Multi-spindle (spindle)	812	813	814	815	816	817	818	819	820	821	822	823	824	825
All other task types	826	827	828	829	830	831	832	833	834	835	836	837	838	839
Station	840	841	842	843	844	845	846	847	848	849	850	851	852	853
Multi-spindle (controller)	854	855	856	857	858	859	860	861	862	863	864	865	866	867
Multi-spindle (spindle)	868	869	870	871	872	873	874	875	876	877	878	879	880	881
All other task types	882	883	884	885	886	887	888	889	890	891	892	893	894	895
Station	896	897	898	899	900	901	902	903	904	905	906	907	908	909
Multi-spindle (controller)	910	911	912	913	914	915	916	917	918	919	920	921	922	923
Multi-spindle (spindle)	924	925	926	927	928	929	930	931	932	933	934	935	936	937
All other task types	938	939	940	941	942	943	944	945	946	947	948	949	950	951
Station	952	953	954	955	956	957	958	959	960	961	962	963	964	965
Multi-spindle (controller)	966	967	968	969	970	971	972	973	974	975	976	977	978	979
Multi-spindle (spindle)	980	981	982	983	984	985	986	987	988	989	990	991	992	993
All other task types	994	995	996	997	998	999	1000	1001	1002	1003	1004	1005	1006	1007
Station	1008	1009	1010	1011	1012	1013	1014	1015	1016	1017	1018	1019	1020	1021
Multi-spindle (controller)	1022	1023	1024	1025	1026	1027	1028	1029	1030	1031	1032	1033	1034	1035
Multi-spindle (spindle)	1036	1037	1038	1039	1040	1041	1042	1043	1044	1045	1046	1047	1048	1049
All other task types	1050	1051	1052	1053	1054	1055	1056	1057	1058	1059	1060	1061	1062	1063
Station	1064	1065	1066	1067	1068	1069	1070	1071	1072	1073	1074	1075	1076	1077
Multi-spindle (controller)	1078	1079	1080	1081	1082	1083	1084	1085	1086	1087	1088	1089	1090	1091
Multi-spindle (spindle)	1092	1093	1094	1095	1096	1097	1098	1099	1100	1101	1102	1103	1104	1105
All other task types	1106	1107	1108	1109	1110	1111	1112	1113	1114	1115	1116	1117	1118	1119
Station	1120	1121	1122	1123	1124	1125	1126	1127	1128	1129	1130	1131	1132	1133
Multi-spindle (controller)	1134	1135	1136	1137	1138	1139	1140	1141	1142	1143	1144	1145	1146	1147
Multi-spindle (spindle)	1148	1149	1150	1151	1152	1153	1154	1155	1156	1157	1158	1159	1160	1161
All other task types	1162	1163	1164	1165	1166	1167	1168	1169	1170	1171	1172	1173	1174	1175
Station	1176	1177	1178	1179	1180	1181	1182	1183	1184	1185	1186	1187	1188	1189
Multi-spindle (controller)	1190	1191	1192	1193	1194	1195	1196	1197	1198	1199	1200	1201	1202	1203
Multi-spindle (spindle)	1204	1205	1206	1207	1208	1209	1210	1211	1212	1213	1214	1215	1216	1217
All other task types	1218	1219	1220	1221	1222	1223	1224	1225	1226	1227	1228	1229	1230	1231
Station	1232	1233	1234	1235	1236	1237	1238	1239	1240	1241	1242	1243	1244	1245
Multi-spindle (controller)	1246	1247	1248	1249	1250	1251	1252	1253	1254	1255	1256	1257	1258	1259
Multi-spindle (spindle)	1260	1261	1262	1263	1264	1265	1266	1267	1268	1269	1270	1271	1272	1273
All other task types	1274	1275	1276	1277	1278	1279	1280	1281	1282	1283	1284	1285	1286	1287
Station	1288	1289	1290	1291	1292	1293	1294	1295	1296	1297	1298	1299	1300	1301
Multi-spindle (controller)	1302	1303	1304	1305	1306	1307	1308	130						

- Task status codes 10 ... 200 are assigned to each task which is completed with a “not accepted” result (“bad” status).
- The “Station Task” summarizes all task statuses assigned to an individual station.
- An “accepted status” is only assigned if all tasks are completed with an “accepted” status.
- Accordingly, a “not accepted status” is assigned as soon as one or more tasks are completed with a “not accepted” status.

2.5 Station Prerequisite Management

The Mitsubishi MEL-FACS software library provides a configurable assembly station prerequisite functionality. Station prerequisites are defined as tasks which have to be completed with an “accepted” status.

Up to 10 prerequisite conditions can be defined per station. Each prerequisite condition can consist of up to 10 alternative tasks, of which, at least one has to be completed with an “accepted” status in order to meet the prerequisite condition.

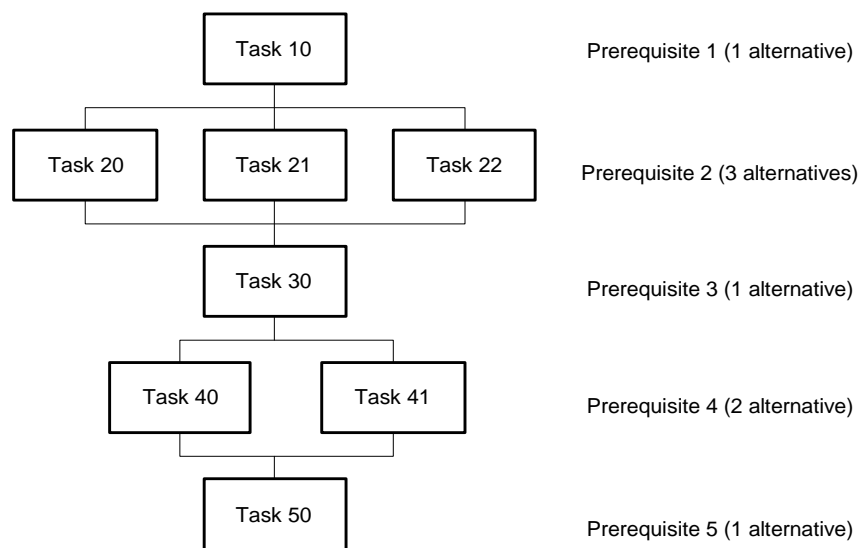


Figure 5 Sample Prerequisite Configuration

- The above figure shows a station prerequisite configuration that defines five prerequisite conditions (prerequisite 1 ... prerequisite 5).
- The prerequisite condition 2 and 4 consist of multiple alternatives.
- The station prerequisite is fulfilled if all prerequisite conditions are met.

The following task status results would cause a “prerequisite not met” condition because the prerequisite condition 4 is not met.

Task	Status
10	251
20	0
21	0
22	251
30	251
40	0
41	21
50	251

Neither task 40 nor task 41 has an “accepted” task status (none of the alternative prerequisite paths has an “accepted” status).

2.6 Model Management

The Mitsubishi MEL-FACS software library supports configurable build data for up to 200 different models. The following graphic shows the basic build data concept.

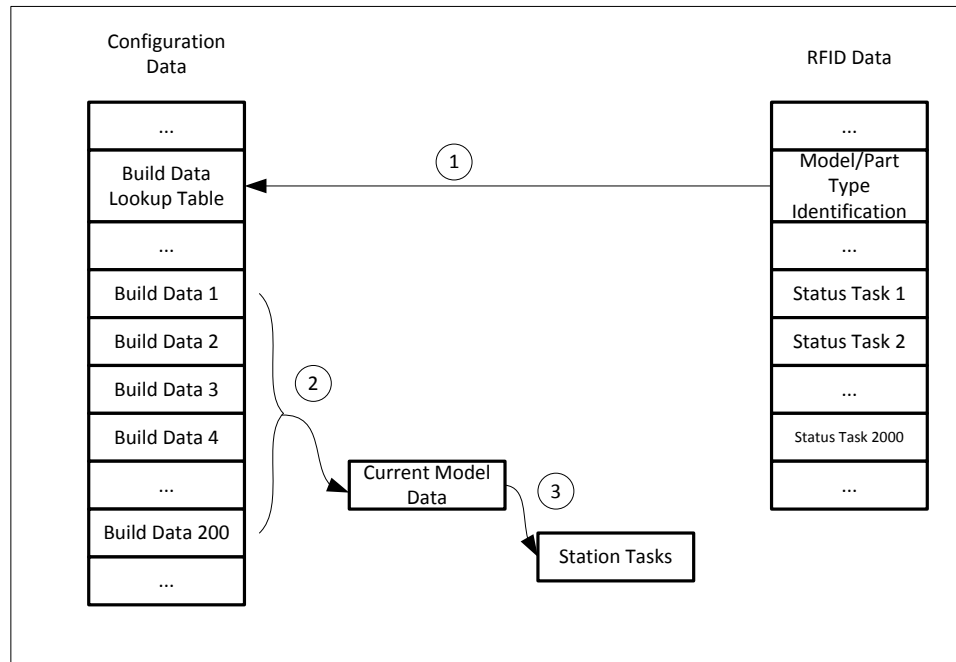


Figure 6 Build Data

1. Lookup Build Data Index

The model specific identification code is extracted from the Model/Part type identification code. The extracted model code is searched in the build data lookup table.

2. Select Build Data Set

The matching build data configuration set is copied into the “Current Model data” memory area.

3. Process Build Data

The build data are passed on to the stations tasks.

2.7 Station Types

The Mitsubishi MEL-FACS software library supports both “continuous moving” and “stop-in-station” assembly concepts in different configurations. The station type is configured by means of the FACS configuration software.

2.7.1. “Continuous Moving” Assembly Line

Continuous moving assembly lines are based on a constant footprint size.

Tasks are executed within the work area. The pallet position (e.g. pallet entering or leaving the station) is determined based on an encoder system or by means of proximity switches.

Continuous Moving Line with RFID

This station type requires an encoder system. The RFID read and write antennas are mounted at the entrance and the exit of the assembly station. The station controller sends a “STOP” signal to the conveyor controller if one or more tasks does not report an “accepted” status code before the work area ends. The operator has to press the reject button in order to resume the conveyor.

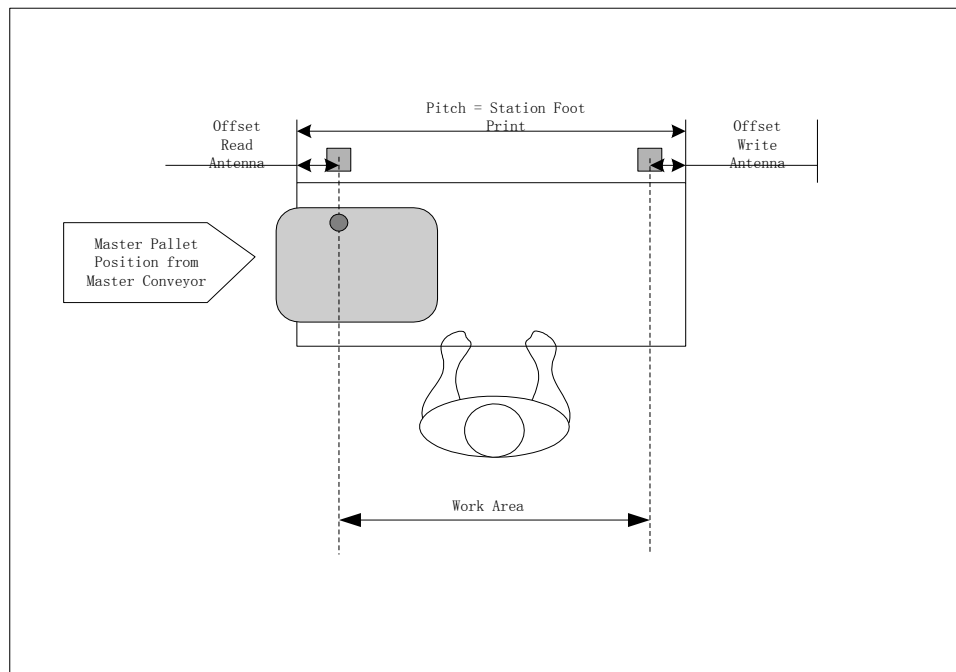
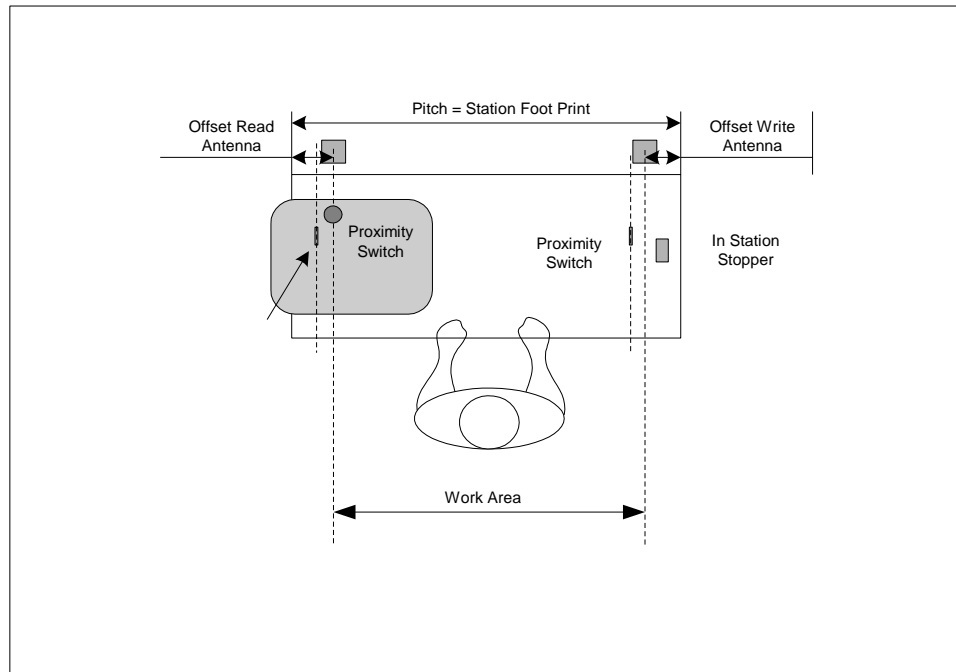


Figure 7 Continuous Moving Assembly Line with RFID

Continuous Moving Line with Stopper

The continuous moving line with stopper is based on a conveyor system which allows stopping the workpiece pallets without stopping the conveyor system.

The tolerated slip between the conveyor system and the pallets makes the use of an encoder system impossible. Tracking of the workpieces (e.g. workpiece entering / leaving the work area) must be accomplished by means of in station proximity switches. All tasks are active within the work area. The station controller sends a “STOP” signal to the conveyor controller if one or more tasks do not report an “accepted” status code before the work area ends (indicated by the second proximity switch). The conveyor controller has to evaluate the “STOP” signal from each station and control the in station stopper accordingly.



The operator has to press the reject button in order to resume the conveyor.

Figure 8 Continuous Moving Assembly Line with Stopper

Note

The station stoppers are controlled by the conveyor controller and not by the individual station controllers.

2.7.2. “Stop-In-Station” Assembly Line

Stop-In-Station assembly lines are based on a pallet stopping in a station and remaining in the station while tasks are performed. The pallet position (e.g. pallet in the station) is determined based on detection by proximity switches.

The RFID read and write antennas are mounted in the assembly station.

Stop-in-Station with Pre-Stop

The stop-in-station with pre-stop is based on a conveyor system which allows stopping the workpiece pallets without stopping the conveyor system. Tracking of the workpieces (e.g. workpiece present in the work area) must be accomplished by means of in station proximity switches. The pre-stop area has an RFID antenna in addition to the RFID antenna at the station stop. All tasks are active within the station work area. The Mitsubishi software library provides a signal to “lower pre-stop” after the task status information is read successfully. The software library also provides a signal for “lower station stop” when all tasks report an “accepted” status code or the operator rejects the workpiece.

Note

The station stoppers are controlled by the user application. The Mitsubishi software library only provides an indication to lower station stops only from the perspective of the tasks complete.

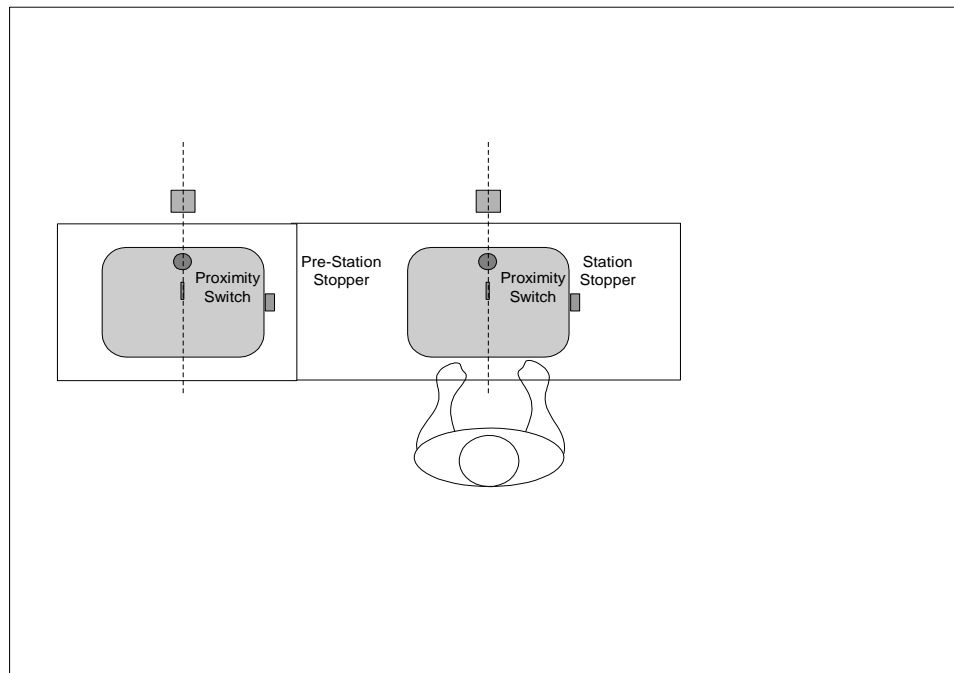


Figure 9 Stop-In-Station with Pre-stop Assembly-Line

Stop-in-Station

The stop-in-station is based on a conveyor system which allows stopping the workpiece pallets without stopping the conveyor system. Tracking of the workpieces (e.g. workpiece present in the work area) must be accomplished by means of in station proximity switches. The station stop area has an RFID antenna for reading and writing task statuses. All tasks are active within the station work area. The Mitsubishi software library provides a signal for “lower station stop” when all tasks report an “accepted” status code or the operator rejects the workpiece.

Note

The station stoppers are controlled by the user application. The Mitsubishi software library only provides an indication to lower station stops from the perspective of the tasks complete.

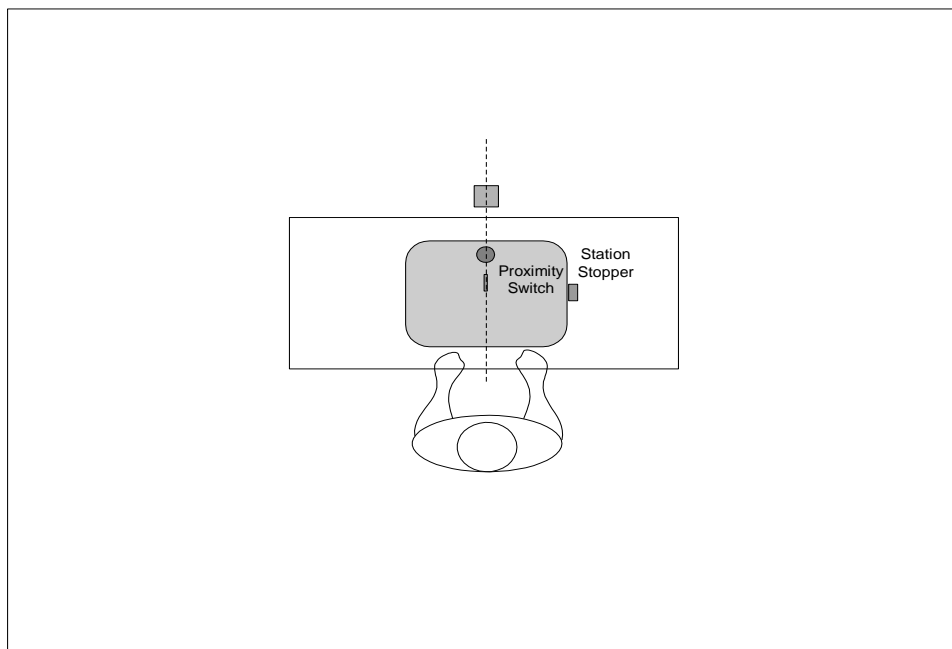


Figure 10 Stop-In-Station without Pre-stop Assembly-Line

In FACS Configuration Software, Work Areas of Stop-in-Station has to be configured as

Manual Station - Left — 0 for Work Area #1 / Automatic Station – Foot print “A” — 0 for Work Area #1 and Set “i_uMultiFootPrintPos” = 0.

The eFlex Manual and Automatic Station configuration screen is shown below.

Station Options Pre-Requisites Stitching Tools Stitching w/ Socket Tray Multi-Spindle Tools Pick Lights and Sensors Error Proofing Sensors Vision System Bar Code Readers Test / Gauge Press / Lube Robot / Servo Universal Indicator Light Mode Task Sequencing																								
Task Number	Task	Task Type	Footprint	Start	End	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
104	Pick Sensor Lookup Task #1	Pick Sensor Task	Left	1	1																			
105	Pick Sensor Lookup Task #2	Pick Sensor Task	Left	2	2																			
106	Pick Sensor Model Type #1	Pick Sensor Task	Left	3	3																			
107	Pick Sensor Model Type #2	Pick Sensor Task	Left	4	4																			
102	Error Proofing Task #1 - Continuous	Error Proofing Task	Left	5	5																			
103	Error Proofing Task #2 - Triggered	Error Proofing Task	Left	6	6																			

Load / Unload Station Options Pre-Requisites Stitching Tools Stitching w/ Socket Tray Multi-Spindle Tools Pick Lights and Sensors Error Proofing Sensors Vision System Bar Code Readers Test / Gauge Press / Lube Robot / Servo Universal Indicator Light Mode Task Sequencing																								
Task Number	Task	Task Type	Footprint	Start	End	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
104	Pick Sensor Lookup Task #1	Pick Sensor Task	Footprint A	1	1																			
105	Pick Sensor Lookup Task #2	Pick Sensor Task	Footprint A	2	2																			
106	Pick Sensor Model Type #1	Pick Sensor Task	Footprint A	3	3																			
107	Pick Sensor Model Type #2	Pick Sensor Task	Footprint A	4	4																			
102	Error Proofing Task #1 - Continuous	Error Proofing Task	Footprint A	5	5																			
103	Error Proofing Task #2 - Triggered	Error Proofing Task	Footprint A	6	6																			

2.8 “Dual GOT” on either side of the Assembly Line

Dual GOT feature of the MEL-FACS gives the ability to mount two GOTs/eHMI on either side of the Assembly Line in the same Stop-in-Station. With this feature, two operators are able to stand on either side of the work piece and work simultaneously on the same work piece. Tasks configured for the station can be shared between two operators. Tasks can be individually configured with independent sequencing by Configuration software. These tasks are displayed on the each GOTs/eHMIs. The Dual GOT Stop-in-station has only one PLC communicating to two GOTs. This feature allows combining independent tasks into one MWS area by reducing the foot print of the line and the tac time. The Task status from both work areas are written into one RFID tag in the stop-in-station.

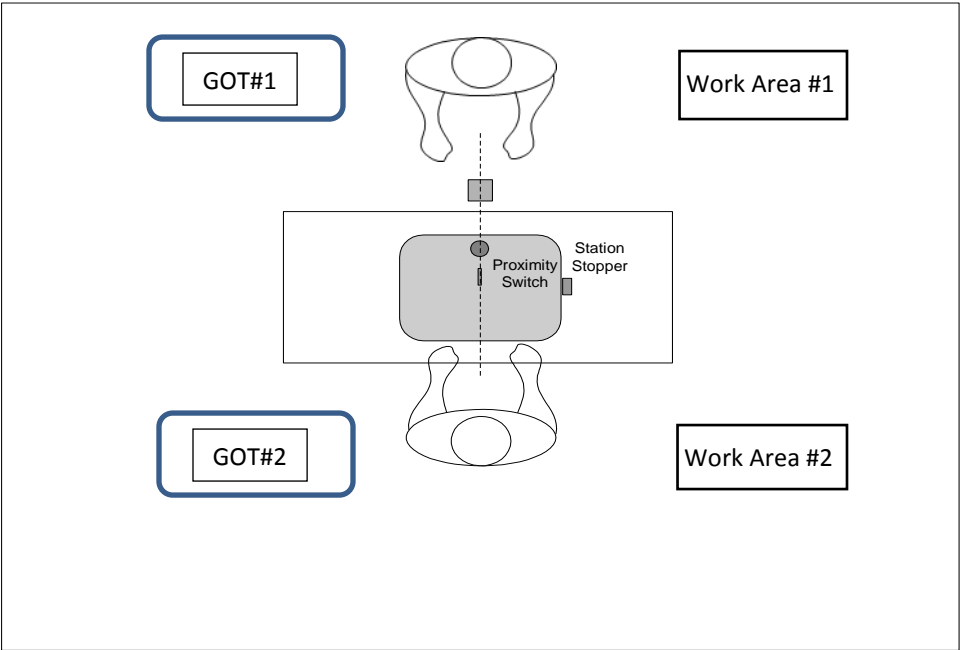


Figure 11 Stop-In-Station with Dual GOTs on either side of Assembly-Line

In FACS Configuration Software, Work Areas of Dual GOT station has to be configured as

Left – 0 for Work Area #1

Right – 1 for Work Area #2

The eFlex Dual GOTs configuration screen is shown below.

Station Configuration Load / Unload Station Options Pre-Requests Stitching Tools Stitching w/ Socket Tray Multi-Spindle Tools Pick Lights and Sensors Error Proofing Sensors Vision System Bar Code Readers Test / Gauge Press / Lube Robot / Servo Universal Indicator Light Mode Task Sequencing																																	
Task Number	Task	Task Type	Footprint	Start	End	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
104	Pick Sensor Lookup Task #1	Pick Sensor Task	Left	1	1																												
105	Pick Sensor Lookup Task #2	Pick Sensor Task	Left	2	2																												
106	Pick Sensor Model Type #1	Pick Sensor Task	Left	3	3																												
107	Pick Sensor Model Type #2	Pick Sensor Task	Left	4	4																												
102	Error Proofing Task #1 - Continuous	Error Proofing Task	Right	1	1																												
103	Error Proofing Task #2 - Triggered	Error Proofing Task	Right	2	2																												

2.9 Multi-Foot Print Stations

Multi-Foot Print stations are two/three independent stop-in-station cells share one PLC and one GOT based on station design. Each stop-in-station will have their own RFID. Tasks configured for the station are shared between two or three cells. Each cell will have their own task sequencing. After all of the tasks completed in each cell, the status of each cell tasks, time taken for each tasks and RFID data will be sent to FACS server. Statuses of tasks in each cell are written into the RFID tag in each cell.

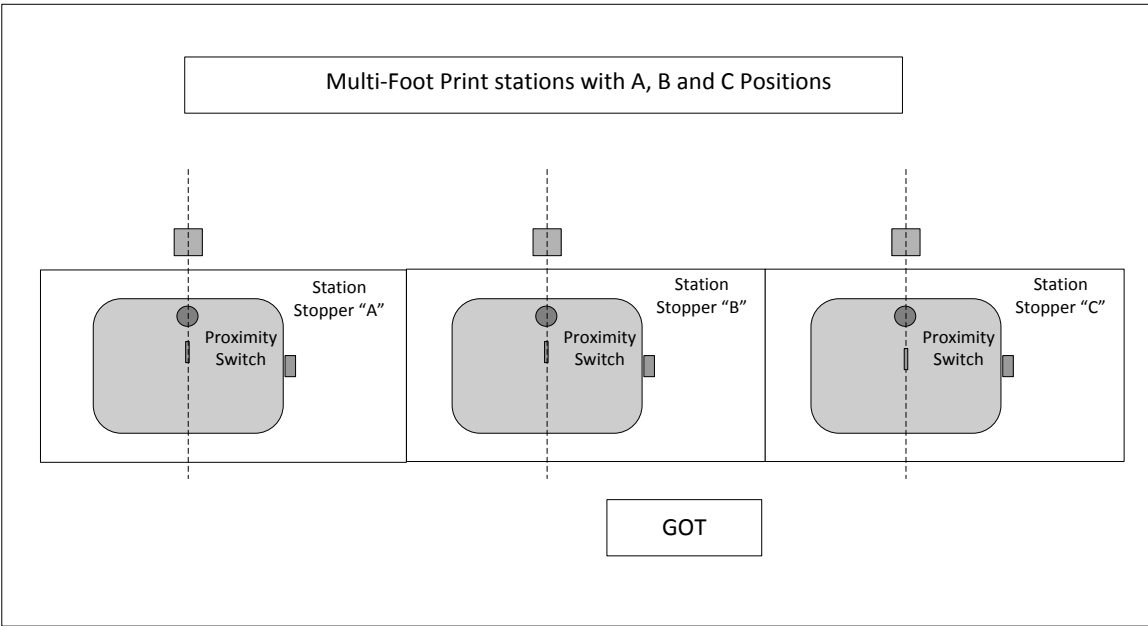


Figure 12 Multi-Foot Print stations with Single GOT

In FACS Configuration Software, Multi-Foot Print Positions A, B and C have to be configured as

Foot Print – 0 for Multi-Foot Print Positions A

Foot Print – 2 for Multi-Foot Print Positions B

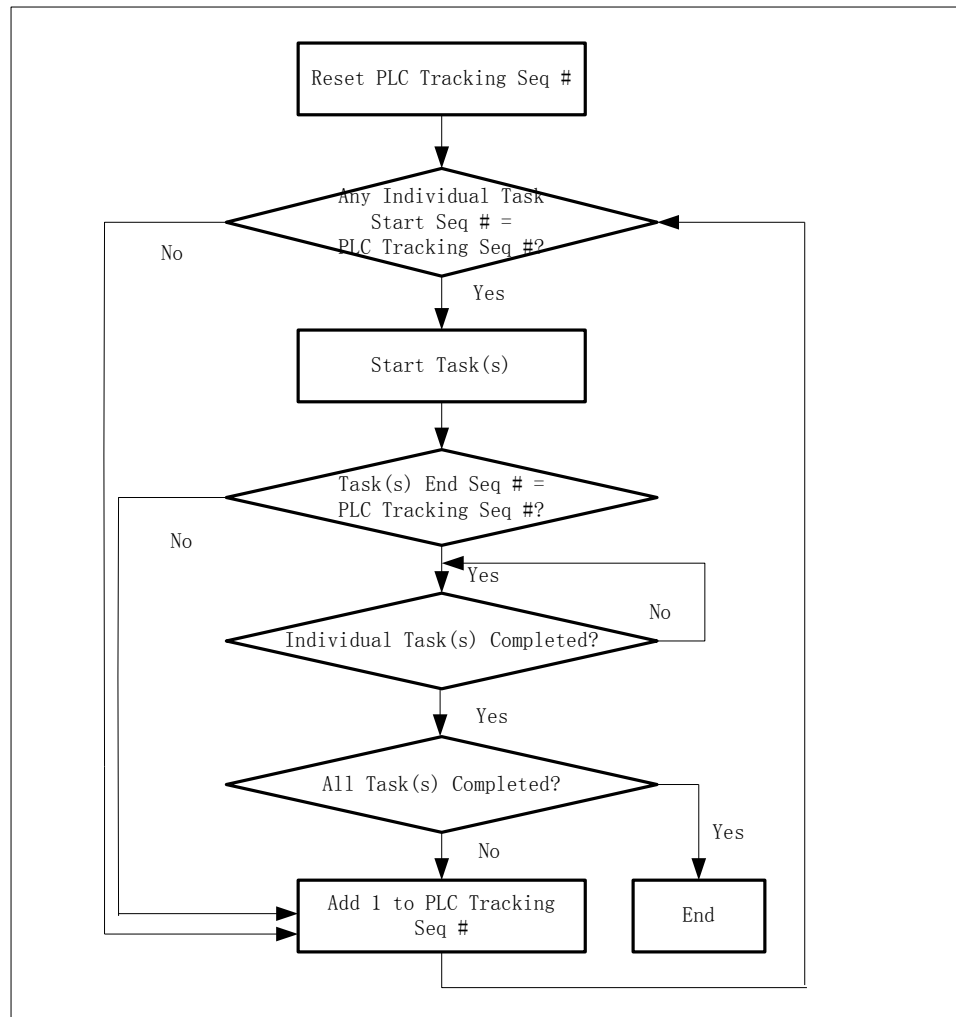
Foot Print – 4 for Multi-Foot Print Positions C

The eFlex Multi-Foot Print station is shown below.

Station Configuration Load / Unload Station Options Pre-Requisites Stitching Tools Stitching w/ Socket Tray Multi-Spindle Tools Pick Lights and Sensors Error Proofing Sensors Vision System Bar Code Readers Test / Gauge Press / Lube Robot / Servo Universal Indicator Light Mode Task Sequencing																																	
Task Number	Task	Task Type	Footprint	Start	End	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
108	Stitching Tool #1	Stitching Tool Task	Footprint A	1	1																												
104	Pick Sensor Lookup Task #1	Pick Sensor Task	Footprint B	1	1																												
105	Pick Sensor Lookup Task #2	Pick Sensor Task	Footprint B	2	2																												
106	Pick Sensor Model Type #1	Pick Sensor Task	Footprint B	3	3																												
107	Pick Sensor Model Type #2	Pick Sensor Task	Footprint B	4	4																												
102	Error Proofing Task #1 - Continuous	Error Proofing Task	Footprint C	1	1																												
103	Error Proofing Task #2 - Triggered	Error Proofing Task	Footprint C	2	2																												

2.10 Task Sequencing Management

All the master tasks and certain sub tasks (Stitching Tool with Socket and Bar Code Reader) support task sequencing configuration. The tasks are individually assigned with a Start and End sequence number. A task will be activated only when all the previous task(s) is completed.



The flowchart of Task Sequence Management is shown in the following figure.

Figure 13 Task Sequencing Management Flowchart

Note

The Mitsubishi MEL-FACS software library manages Task Sequencing internally.

2.11 Workpiece Re-Run Management

The master tasks support Re-Run configuration. Any workpiece will be Re-Run if “Always Re-Run” is configured. A workpiece with current status code as “Not Accept” will be Re-Run if “Re-Run Rejects” is configured. The new status code will overwrite the previous status code of the workpiece.

The workpiece will not be Re-run if “Never Re-Run” is configured.

Note

The Mitsubishi MEL-FACS software library manages Re-Run internally.

2.12 Task Bypass Management

Individual tasks and station can be bypassed by means of configuration parameter. The bypass configuration is handled as follows:

Station Bypass

All tasks are automatically assigned the “bypassed” status code. The tasks are not activated.

Task Bypass

All bypassed tasks are automatically assigned the “bypassed” status code. Bypassed tasks are not activated.

Note

The Mitsubishi MEL-FACS software library manages station and task bypass configuration internally.

2.13 “Workpiece Reject” Management

For manual station, reject is required, if one or multiple tasks can not be completed with an “accepted” status after retry. The “reject” status (result code 20...21 depending on the task type) will be assigned to all tasks which did not report any status at that point.

For automatic station, if one or multiple tasks cannot be completed with an “accepted” status, the “reject” status (result code 20...21 depending on the task type) will be assigned to all tasks which did not report any status at that point.

Already existing result codes (accepted” and “not accepted” task result codes) are not overwritten by the “reject” result code.

The reject process procedures are depending on the station type.

Continuous moving assembly line

If a task did not finish within the available footprint of the task, the “STOP” signal has to be sent to the conveyor controller in order to stop the conveyor system.

A manual “reject” by an operator causes the task to signal a “task done” and resets “stop request”. The conveyor controller restarts the conveyor system.

The conveyor system of a “continuous moving line with stops” is actually not stopped. Station stops prevent the workpieces (pallets) to leave the stations. The station stops are controlled (or synchronized) by the conveyor controller.

Stop in stations assembly line

The workpieces (pallets) in a “stop in station” assembly line are individually released by the stations. A workpiece is only supposed to be released if all tasks assigned to the station are completed with an “accepted” status.

A workpiece release request has to be blocked if any of the tasks have not completed with an “accepted” status.

A manual “reject” by an operator causes all tasks to signal a “All_Task_Completed” and a subsequent “release” request can be executed.

2.14 “Workpiece Release” Management

The workpiece (pallet) will be released after all tasks are done.

Furthermore the following workpiece releasing strategies are also available in FACS configuration system.

Note

The “workpiece release” functionality is only available for “stop in station” assembly stations.

Release workpiece after cycle time expired

A workpiece (pallet) is automatically released after a configurable cycle time expired and all tasks are done.

Release workpiece after all tasks are done

A workpiece (pallet) is automatically released as soon as all tasks are done and a configurable hold time expired.

Manual early release

A manual “early release” can be initiated by an operator by means of a push button. The “early release” can be enabled for both release strategies by means of a configuration setting.

Note

Tasks report the status “done” if either all tasks finished with an accepted status or if the workpiece was manually rejected by an operator.

A manual “early release” can be initiated by an operator by means of a push button. The “early release” can be enabled for both release strategies by means of a configuration setting.