



Figure 4  
Temporal Mapping of Equipment Module [Equipment SEMI E10](#) States to an IPS [Equipment SEMI E10](#) State

7.4.6.1 First, an IPS as a whole ~~must~~shall be tracked in either NST or in operations time. Any IPS that is not scheduled to be utilized in production shall be tracked in NST.

**NOTE 16:**NOTE 17: By tracking inactive IPSs in NST, productive time is more accurately attributed to active IPSs, directly affecting metrics for IPSs involving productive time. To the extent that multiple IPSs are simultaneously active and have shared processing equipment modules, productive time cannot be accurately attributed to individual IPSs, and metrics for IPSs involving productive time may be less useful.

7.4.6.2 Next, if the IPS is not tracked in NST and if any processing equipment module in the IPS is in PRD, then the IPS is in PRD. If a processing equipment module in PRD belongs to more than one IPS that is not tracked in NST, then all such IPSs are in PRD.

**NOTE 17:**NOTE 18: Nonprocessing equipment modules, such as wafer handling equipment modules, are not considered when determining PRD for an IPS.

7.4.6.3 Otherwise, based on the reliability function of equipment module [equipment](#) states for an IPS, if an IPS is in a downtime state due only to equipment modules in UDT, then the IPS is in UDT.

8.2 *Equipment Reliability* — Measurement of the equipment's ability to perform its intended function for a specified period of time, without failure. For IPS<sub>S</sub> and MPCTs, all of the metrics in this section will shall be based on the temporal mapped equipment states for the IPS<sub>S</sub> and MPCTs as defined in § 7.

### 8.2.1 *Mean Time Between Failure<sub>S</sub> Calculations*

8.2.1.1 *MTBF<sub>u</sub>* — Mean uptime between failures; the average equipment system uptime that the equipment was capable of performing its intended function between failures; uptime divided by the number of failures during that time. Only uptime is included in this calculation. Failures that occur coincident with an attempt to change from NST or SDT to an uptime state are included in this calculation.

$$MTBF_u = \frac{\text{uptime}}{\# \text{ of failures during uptime}} \quad (4)$$

8.2.1.2 *MFD<sub>u</sub>* — Mean failure duration for failures during uptime; unscheduled downtime for failures during uptime divided by the number of failures during uptime.

$$MFD_u = \frac{\text{unscheduled downtime for failures during uptime}}{\# \text{ of failures during uptime}} \quad (5)$$

8.2.1.3 *E-MTBF<sub>u</sub>* — Mean uptime time between equipment-related failures; the average equipment system uptime that the equipment was capable of performing its intended function between these equipment-related failures; uptime divided by the number of equipment-related failures during that time. Only uptime is included in this calculation. Equipment-related failures that occur coincident with an attempt made to change from NST or SDT to an uptime state are included in this calculation.

$$E-MTBF_u = \frac{\text{uptime}}{\# \text{ of equipment-related failures during uptime}} \quad (6)$$

8.2.1.4 *MTBF<sub>p</sub>* — Mean productive time between failures; the average time the equipment performed its intended function between failures; productive time divided by the number of failures during that time. Only productive time is included in this calculation. Failures that occur when an attempt is made to change from any equipment state other than UDT to PRD are included in this calculation.

$$MTBF_p = \frac{\text{productive time}}{\# \text{ of failures during productive time}} \quad (7)$$

8.2.1.5 *MFD<sub>p</sub>* — Mean failure duration for failures during productive time; unscheduled downtime for failures during productive time divided by the number of failures during productive time.

$$MFD_p = \frac{\text{unscheduled downtime for failures during productive time}}{\# \text{ of failures during productive time}} \quad (8)$$

8.2.1.6 *E-MTBF<sub>p</sub>* — Mean productive time between equipment-related failures; the average time the equipment performed its intended function between equipment-related failures; productive time divided by the number of equipment-related failures during that time. Only productive time is included in this calculation. Equipment-related failures that occur when an attempt is made to change from any equipment state other than UDT to PRD are included in this calculation.

$$E-MTBF_p = \frac{\text{productive time}}{\# \text{ of equipment-related failures during productive time}} \quad (9)$$

### 8.2.2 *Mean Cycles Between Failure<sub>S</sub> Calculations*

8.2.2.1 *MCBF<sub>u</sub>* — Mean cycles between failures during uptime; the average number of equipment cycles between failures during uptime.

$$MCBF_u = \frac{\text{equipment cycles during uptime}}{\# \text{ of failures during uptime}} \quad (10)$$

**1-Sided Lower Confidence Bound Factors for the MTBF, MCBF, or MWBF (Time-Censored or, Cycle-, or Work-Censored Data)**

Number of Failures, $r$	Confidence Level						
	60%	70%	80%	85%	90%	95%	97.5%
0	1.091	0.831	0.621	0.527	0.434	0.334	0.271
1	0.494	0.410	0.334	0.297	0.257	0.211	0.179
2	0.644	0.553	0.467	0.423	0.376	0.318	0.277
3	0.718	0.630	0.544	0.499	0.449	0.387	0.342
4	0.763	0.679	0.595	0.550	0.500	0.437	0.391
5	0.795	0.714	0.632	0.589	0.539	0.476	0.429
6	0.817	0.740	0.661	0.618	0.570	0.507	0.459
7	0.834	0.760	0.684	0.642	0.595	0.532	0.485
8	0.848	0.777	0.703	0.662	0.616	0.554	0.508
9	0.859	0.790	0.719	0.679	0.634	0.573	0.527
10	0.868	0.802	0.733	0.694	0.649	0.590	0.544
12	0.883	0.821	0.755	0.718	0.675	0.617	0.572
15	0.899	0.841	0.780	0.745	0.704	0.649	0.606
20	0.916	0.864	0.809	0.777	0.739	0.688	0.647
30	0.935	0.892	0.844	0.816	0.783	0.737	0.700
50	0.953	0.918	0.879	0.856	0.829	0.790	0.759
100	0.969	0.943	0.915	0.897	0.877	0.847	0.822
500	0.987	0.976	0.962	0.954	0.944	0.929	0.916

A1-2.7 Use Table A0 for time-, cycle-, work-, or failure-censored data. Multiply the MTBF, MCBF, or MWBF point estimate to obtain an upper bound at the given confidence level.

**1-Sided Upper Confidence Bound Factors for the MTBF, MCBF, or MWBF**

Number of Failures, $r$	Confidence Level						
	60%	70%	80%	85%	90%	95%	97.5%
1	1.958	2.804	4.481	6.153	9.491	19.496	39.498
2	1.453	1.823	2.426	2.927	3.761	5.628	8.257
3	1.313	1.568	1.954	2.255	2.722	3.669	4.849
4	1.246	1.447	1.742	1.962	2.293	2.928	3.670
5	1.205	1.376	1.618	1.795	2.055	2.538	3.080
6	1.179	1.328	1.537	1.687	1.904	2.296	2.725
7	1.159	1.294	1.479	1.610	1.797	2.131	2.487
8	1.144	1.267	1.435	1.552	1.718	2.010	2.316
9	1.133	1.247	1.400	1.507	1.657	1.917	2.187
10	1.123	1.230	1.372	1.470	1.607	1.843	2.085
12	1.108	1.203	1.329	1.414	1.533	1.733	1.935
15	1.093	1.176	1.284	1.357	1.456	1.622	1.787
20	1.077	1.147	1.237	1.296	1.377	1.509	1.637