169.4.4 MPSE state diagram

The MPSE shall implement the behavior of the state diagram shown in Figure 169–3 and Figure 169–4.

169.4.4.1 Conventions

The notation used in the state diagram follows the conventions of state diagrams as described in 145.2.5.2.

169.4.4.2 Variables

The MPSE state diagram uses the following variables:

discover_low_tare_var
: A variable that stores the baseline $I_{Discovery}$ when MPDs are receiving power from the discovery algorithm, but not issuing a discovery response. This baseline $I_{Discovery}$ will be compared against later discovery_low $I_{Discovery}$ measurements to determine which types of MPDs are connected to the mixing segment. .

mark_number
: A variable that counts the mark events in a single discovery cycle. This variable is reset in the IDLE state, and incremented at each high mark event.

mpse_enable
: A variable that selects MPSE operation. This variable may be set by the MPSE at any time.
Values:
FALSE: All MPSE functions disabled (behavior is as if there was no MPSE functionality).
TRUE: Normal MPSE operation.

mpse_ready
: A variable that is asserted in an implementation-dependent manner. This variable may be set by the MPSE at any time.
Values:
FALSE: The MPSE is not ready to discover the mixing segment.
TRUE: The MPSE is ready to discover the mixing segment.

mpd_type0_discovered
: A variable that indicates at least one valid MPD supporting only Type 0 is connected to the mixing segment.
Values:
FALSE: No valid MPDs supporting only Type 0 are connected to the mixing segment.
TRUE: At least one valid MPD supporting only Type 0 is connected to the mixing segment.

mpd_type1_discovered
: A variable that indicates at least one valid MPD supporting only Type 1 is connected to the mixing segment.
Values:
FALSE: No valid MPDs supporting only Type 1 are connected to the mixing segment.
TRUE: At least one valid MPD supporting only Type 1 is connected to the mixing segment.

mpd_mixed_discovered
: A variable that indicates at least one valid MPD supporting both Type 0 or Type 1 is connected to the mixing segment.

Values:

FALSE: No valid MPDs supporting both Type 0 and Type 1 are connected to the mixing segment.

TRUE: At least one valid MPD supporting both Type 0 or Type 1 is connected to the mixing segment.

discover_fault

A variable indicating if $I_{Discovery}$ measured by the MPSE during the most recent discover_high or discover_low state is equal to or greater than $I_{Discovery\_LIM}$ as defined in Table 169–3. This variable is set per this description.

Values:

FALSE: Measured $I_{Discovery}$ was less than $I_{Discovery\_LIM}$ during the most recent discover_high or discover_low state.

TRUE: Measured $I_{Discovery}$ was equal to or greater than $I_{Discovery\_LIM}$ during the most recent discover_high or discover_low state.

overload_detected

A variable indicating if the MPSE output current has been in an overload condition; see 169.4.9. This variable is set per this description.

Values:

FALSE: The MPSE has not detected an overload condition.

TRUE: The MPSE has detected an overload condition.

power_stable

A variable that is asserted when the MPSE completes inrush and is ready to source full operating power to MPD loads.

Values:

FALSE: The MPSE is either not applying full operating voltage or has begun applying full operating voltage but is still in the INRUSH state

TRUE: The MPSE has begun steady-state operation and is ready to enter the POWER_ON state.

short_circuit_detected

A variable indicating if the MPSE output has been in a short circuit condition; see 169.4.10. This variable is set per this description.

Values: FALSE: The MPSE has not detected a short circuit condition.

TRUE: The MPSE has detected a short circuit condition.

tci_powered

A variable that controls the circuitry that the MPSE uses to power the TCI.

Values: FALSE: The circuitry that applies operating power to the TCI is disabled.

TRUE: The circuitry that applies operating power to the TCI is enabled.

169.4.4.3 Timers

All timers operate in the manner described in 14.2.3.2 with the following addition: a timer is reset and stops counting upon entering a state where "stop_x_timer" is asserted.

mark_timer

A timer used to delay measurement of the mark current after applying a high mark voltage. See Table 169–3.

measure_timer

A timer used to delay measurement of the discovery low event current after applying a low event voltage. See Table 169–3.

mpse_inrush_timer

A timer used to limit the duration of the inrush event. See Table 169–5.

tdiscover_high_timer
A timer used to limit the discovery_high event time. See Table 169–3.

tdiscover_low_timer
A timer used to limit the discovery_low event time. See Table 169–3.

ted_timer
A timer used to regulate a subsequent attempt to power a MPD after an error condition causes power removal. See T_{ED} in Table 169–5.

ttpsdo_timer
A timer used to monitor the dropout of the TPS. See 169.4.11.1 and Table 169–5.

169.4.4.4 Functions

The variable formed by the function name appended with "_done" is used to indicate when the function has completed. This variable is set to FALSE when the function is called and is set to TRUE once the function is complete and its output variables are valid.

present_mark

This function produces the discovery mark voltage, V_{Mark}, as defined in Table 169–3.

do_discovery_high
This function returns the following variables:

discover_short: A variable indicating if I_{Mark} measured by the MPSE during do_discovery_high is greater than I_{Mark_short} as defined in Table 169–3. This variable is set per this description.

Values:

FALSE: Measured I_{Mark} is less than I_{Mark_short} during do_discovery_high.

TRUE: Measured I_{Mark} is equal to or greater than I_{Mark_short} during do_discovery_high.

discover_high_var: Measured I_{Mark} during the most recent discovery_high_mark event.

present_low

This function produces the discovery low voltage, $V_{Discovery}$, as defined in Table 169–3.

do_discovery_low

This function measures $I_{Discovery}$. This function returns the following variables:

discover_low_val: Measured $I_{Discovery}$ during the most recent discovery_low event.

check_discovery_all
This function evaluates the results of the most recent discovery mark event. The measured $I_{Discovery}$ is compared against I_{Mark} from the previous discovery_high_mark event to determine if MPDs are present (see Table 169-3). This function returns the following variable:

mpd_discovered: This variable indicates the presence or absence of a valid MPD on the mixing segment.

Values:

open_circuit: The MPSE has detected an open circuit.

valid: The MPSE has discovered at least one MPD is connected to the mixing segment.

check_discovery_type

This function determines if MPDs are responding to the slot by subtracting the variable discover_low_tare_var from the measured $I_{Discovery}$ to determine if an MPD is responding to this discovery_low event. This function returns the following variable:

mpd_type_discovered: This variable indicates the presence or absence of a valid MPD corresponding to the discovery slot being probed.

Values:

TRUE: At least one MPD responded to the most recent discovery event.

FALSE: No MPDs responded to the most recent discovery event.

do_discovery_eval

This function evaluates the results from the previous discovery states to determine if at least one MPD is requesting power that is compatible with the MPSE's system type.
This function returns the following variables:

discover_compatible_mpd:
Values:

TRUE: At least one MPD is requesting power that is compatible with the MPSE system type.

FALSE: No MPDs are requesting power that is compatible with the MPSE system type.

do_MPSE_reset

This function produces the reset event voltage (V_{MPSE_reset}) at the the TCI.

169.4.4.5 State diagrams

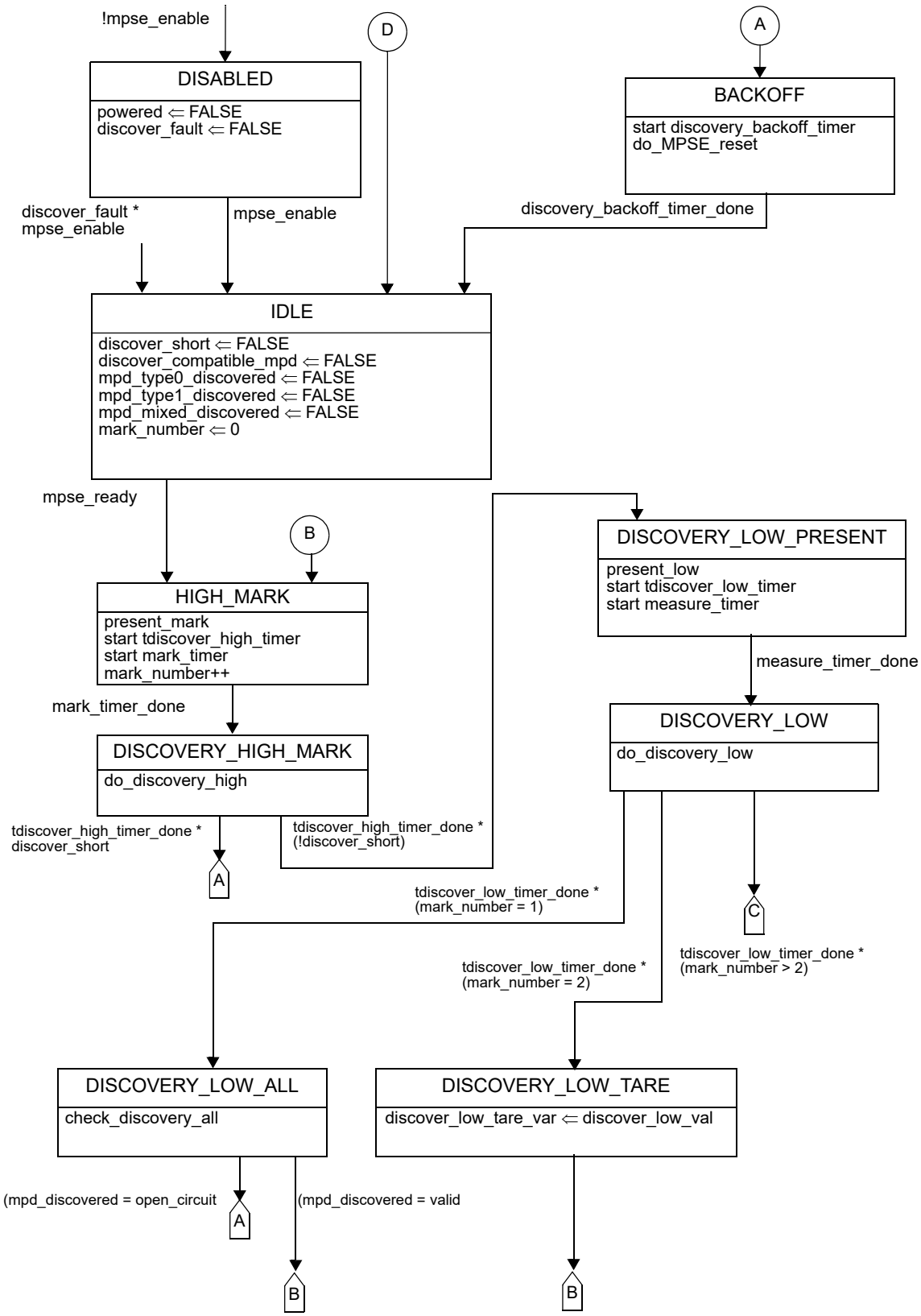

Figure 169–3—Top level MPSE state diagram, part a

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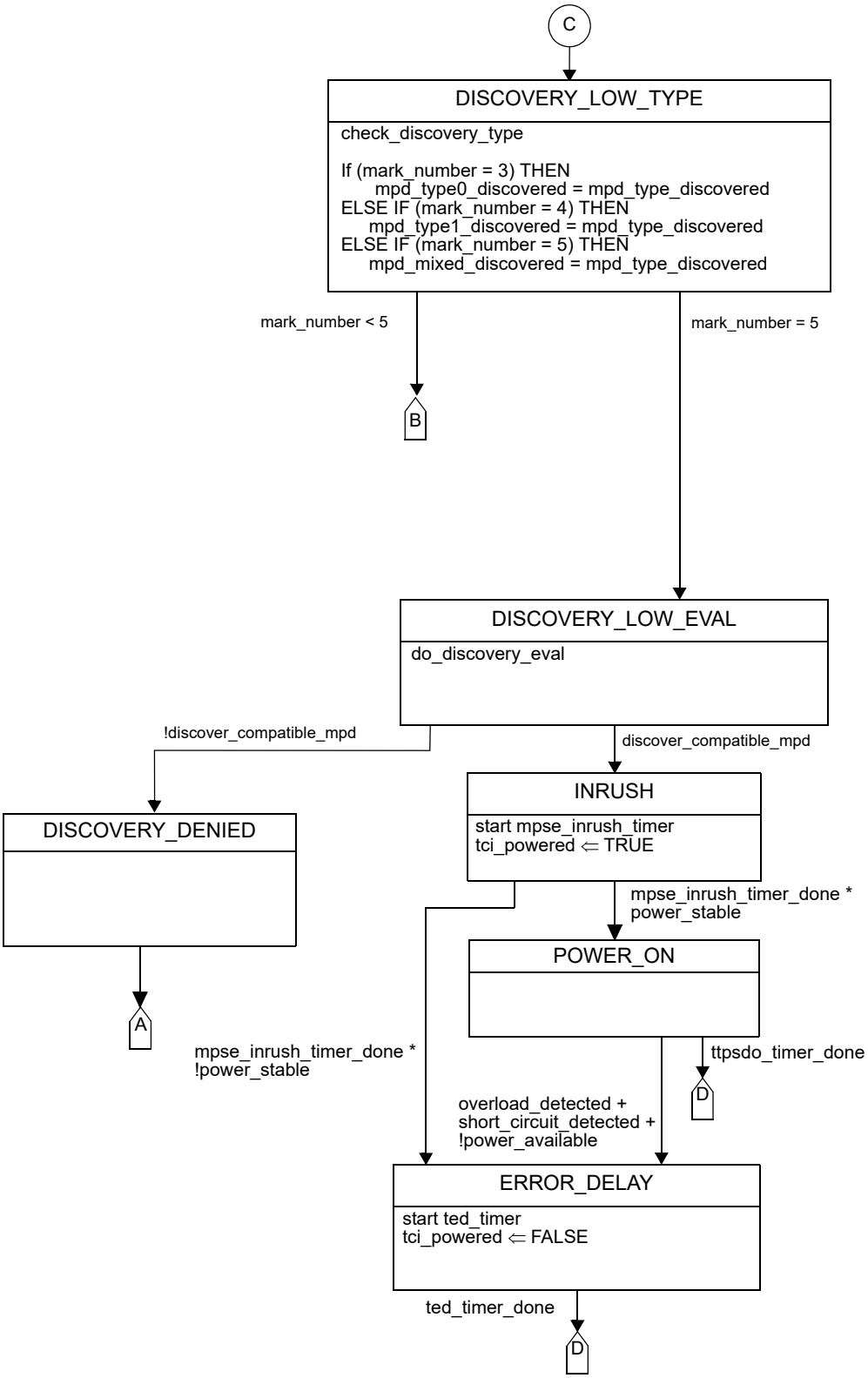

Figure 169–4—Top level MPSE state diagram, part b

169.4.5 MPSE overview

Prior to application of full operating voltage, the MPSE determines the presence of at least one valid MPD (see Table 169–3). An MPSE may apply full operating voltage if it is able to successfully discover a voltage-compatible MPD and does not apply full operating voltage if an invalid discovery signature is measured (see Table 169–4).

After full operating voltage has been applied, the MPSE removes full operating voltage in response to a command from the management entity that results in mpse_enable being set to disable. For example, the management entity could monitor the link to determine at least one MPD remains attached, and there have been no changes in the network topology.

Additionally, while voltage is applied the MPSE monitors the current drawn and removes power if it detects an overload (see 169.4.9), short-circuit or other fault (see 169.4.10), or for the absence of TPS (see 169.4.11).

169.4.6 Discovering the presence of an MPD before powering

The ability for the MPSE to query all attached MPDs to determine the assortment of system types present on the link is called discovery. Discovery also serves the function of checking that the link is clear of faults before applying power.

Discovery consists of a series of discover high and discover low events as defined in the state diagram in Figure 169–3 and Figure 169–4.

When the MPSE is presenting a mark event voltage in a HIGH_MARK and DISCOVERY_HIGH_MARK state, as shown in the state diagram of Figure 169–3 and Figure 169–4, the MPSE supplies V_{Mark} voltage to the TCI subject to the $T_{Discovery\_high}$ timing specification. The MPSE waits $T_{Mark\_measure}$ between applying the mark event voltage at the entrance of HIGH_MARK before measuring the mark event current $I_{Discovery\_i}$ in DISCOVERY_HIGH_MARK. $T_{Mark\_measure}$ and $T_{Discovery\_high}$ are referenced from the application of V_{Mark} min to ignore initial transients. If the current $I_{Discovery}$ measured in a DISCOVERY_HIGH_MARK state exceeds I_{Mark_short} the MPSE returns to the BACKOFF state.

When the MPSE is presenting a discover low event voltage in any of the DISCOVERY_LOWx states (i.e., DISCOVERY_LOW_PRESENT, DISCOVERY_LOW, DISCOVERY_LOW_ALL, DISCOVERY_LOW_TARE, DISCOVERY_LOW_TYPE, or DISCOVERY_LOW_EVAL), as shown in the state diagram of Figure 169–3 and Figure 169–4, the MPSE supplies $V_{Discovery}$ voltage to the TCI subject to the $T_{Discovery\_low}$ timing specification. The MPSE waits $T_{Discover\_measure}$ between the entrance of a DISCOVERY_LOW_PRESENT state and measurement of the discovery event current, $I_{Discovery}$ in the DISCOVERY_LOW state. $T_{Discover\_measure}$ is referenced from the application of $V_{Discovery}$ max to ignore initial transients.

The MPSE shall limit current to $I_{Discovery\_LIM}$ during all discovery events, DISCOVERY_LOWx, HIGH_MARK, and DISCOVER_HIGH_MARK.

If the MPSE returns to BACKOFF, it maintains the TCI voltage at V_{MPSE_reset} for $T_{Discovery\_backoff}$ before starting a new discovery cycle.

The MPSE waits at least $T_{Backoff}$ before reattempting discovery. An MPSE may successfully complete discovery, but then opt not to power the link.

Under all conditions, an MPSE shall present an invalid MPD discovery signature with one of the attributes as defined in Table 169–4.

Table 169–3—MPSE discovery parameters

Item	Parameter	Symbol	Min	Max	Units	Additional Information
1	Discovery high mark voltage	V_{Mark}	16.1	19.1	V	
2	Discovery low voltage	$V_{Discovery}$	7.4	11.9	V	
3	Discovery current limit	$I_{Discovery\_LIM}$	50	100	mA	
4	Discovery high event time	$T_{Discovery\_high}$	7	-	ms	
5	Discovery low event time	$T_{Discovery\_low}$	20	TBD	ms	
6	Discovery time	$T_{Discovery}$	-	TBD	ms	
7	Discovery backoff time	$T_{Backoff}$	150	-	ms	
8	Mark short circuit threshold	I_{Mark_short}	3	4	mA	
9	Discovery_all MPD present range	$I_{MPD\_present}$	0.8	40	mA	$I_{Discovery}$ - I_{Mark}
10	MPD type present	I_{Type_presen}	0.8	40	mA	$I_{Discovery}$ - I_{Tare}
11	Mark measurement delay	$T_{Mark\_measure}$	5	-	ms	
12	Discovery measurement delay	$T_{Discover\_measure}$	6.5	-	ms	Based on Mark-Discover fall time (10nF Cpd)
13	Discovery reset	V_{MPSE_reset}	0	2.8	V	

Table 169–4—Discovery rejection criteria

Item	Parameter	Symbol	Min	Max	Units
1	Reject discovery - short circuit	I_{bad}	30	-	mA
2	Reject discovery - open circuit	I_{open}	-	200	µA

169.4.7 MPSE output requirements

When the MPSE provides power to the MPSE TCI, it shall conform to the electrical limits in Table 169–5.

169.4.8 Continuous output power in POWER_ON state

P_{MPSE} min is the minimum continuous power that the MPSE is capable of supplying as defined in Table 169–5. External safety requirements limit the power an MPSE can supply. Often this value is 100 W

Table 169–5—PSE output requirements

Item	Parameter	Symbol	Unit	Min	Max	Type	Additional Information
1	DC output voltage during POWER_ON state	$V_{MPSE(PON)}$	V	26	30	0	
				45	50	1	
2	Continuous output capability in POWER_ON state	P_{MPSE}	W	26	100	0	
				45	100	1	
3	Output slew rate		dV/dt	TBD	TBD	ALL	
4	Output current - at short circuit condition	I_{LIM}	A	TBD	TBD	ALL	
5	Short-circuit time limit	T_{LIM}	ms	10	75	ALL	
6	Inrush time	T_{Inrush}	ms	10	20	ALL	
7	MPD maintain power signature dropout time limit	T_{TPSDO}	ms	320	400	ALL	
8	PD TPS time for validity	T_{TPS}	ms	6	-	ALL	
9	DC TPS current	I_{HOLD}	A	4	9	ALL	
10	Error delay timing	T_{ED}	ms	750	-	ALL	
11	Overload current	I_{CUT}	A	$P_{MPSE}/V_{MPSE(PON)}$	-	ALL	
12	Overload time limit	T_{CUT}	ms	50	70	ALL	

max, but an MPSE designer is encouraged to refer to the safety standards that will govern the desired installation (i.e., the target market for a given MPSE).

169.4.9 Overload current

If the current exceeds I_{CUT} for longer than T_{CUT}, the MPSE may remove power. The cumulative duration of T_{CUT} is measured using a sliding window of 1 second width.

169.4.10 Short circuit current

During operation in the INRUSH and POWER_ON states, the MPSE shall limit the current to I_{LIM} for a duration of up to T_{LIM} in order to account for MPSE dV/dt transients at the MPI as defined in Table 169–5. If I_{MPSE} exceeds I_{LIM} min during the POWER_ON state, the MPSE output voltage may drop below $V_{MPSE(PON)}$ min.