Table 169–6—MPD pinout

Conductor	Polarity A	Polarity B
1	Positive V_{MPD}	Negative V_{MPD}
2	Negative V_{MPD}	Positive V_{MPD}

Current at an MPD MPI is defined as negative when current flows out of the higher voltage pin of the MP1 or MP2 connection and flows into the lower voltage pin of the same MP1 or MP2 connection, respectively.

For compliance, MPD current is measured as the sum of MPI currents, MP1+MP2. Current shall be measured as the sum of both higher voltage pins on MP1 and MP2, or both lower voltage pins on MP1 and MP2.

NOTE - One of the currents on MP1 or MP2 will be positive and the other will be negative; making this "sum" a difference. The current used by the MPD lowers the current supplied to the output MP feeding the rest of the MPDs that follow in the mixing segment.

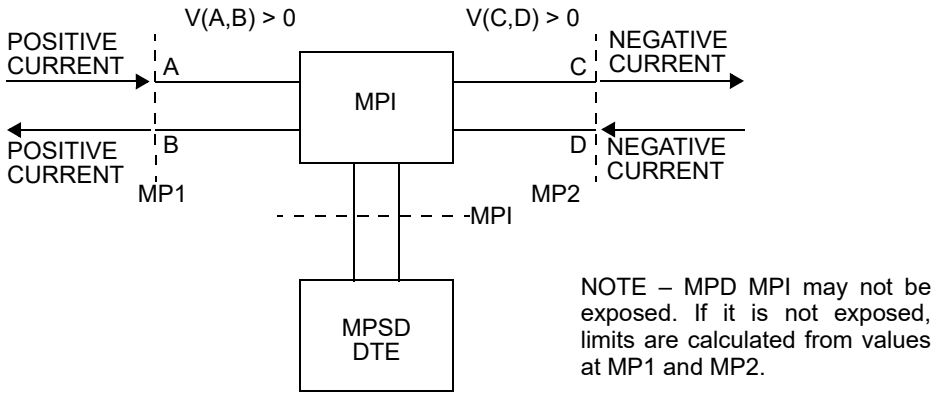

Figure 169–5—Current at an MPD MPI

169.5.3 MPD state diagram

The MPD shall implement the behavior of the state diagram shown in Figure 169–6, Figure 169–7, and Figure 169–8.

169.5.3.1 Conventions

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

169.5.3.2 Constants

$I_{Inrush\_MPD\_max}$
: The maximum MPD inrush current I_{Inrush_MPD} max (see Table 169–8).

$V_{Discovery\_th}$
: Mark discovery threshold voltage (see Table 169–7)

$V_{Reset\_MPD\_max}$
: The maximum MPD reset voltage V_{Reset_MPD} max (see Table 169–7).

V_{Reset_th}
Reset voltage threshold (see Table 169–7).

V_{type0_th}
Threshold between discovery and type 0 operating region.

V_{type1_th}
Threshold between Type 0 operating region and Type 1 operating region.

169.5.3.3 Variables

The MPD state diagram uses the following variables:

dte_power_required
A variable indicating that the MPD is enabled and should request power from the MPSE by participating in the discovery protocol, and when the MPSE sources power to apply the TPS to keep the MPSE sourcing power. This variable may be set by the MPD at any time.
Values: FALSE: MPD functionality is disabled.
TRUE: MPD functionality is enabled.

mpd_reset
An implementation-specific variable that unconditionally resets the MPD state diagram to OFFLINE. This variable may be set by the MPD at any time.
Values: FALSE: The device has not been reset.
TRUE: The device has been reset.

mpd_type
A variable indicating the MPD type.
Values: 0: The MPD supports only Type 0.
1: The MPD supports only Type 1.
mixed: The MPD supports both Type 0 and Type 1.

present_sig
Controls presenting the current presented (see Table 169–7 and Table 169–8) by the MPD.
Values: IDLE: The MPD presents I_{MPD_idle} at the MPI.
MARK: The MPD presents I_{MPD_mark} at the MPI.
DISCOVERY: The MPD presents $I_{MPD\_discover}$ at the MPI.
INRUSH: The MPD presents I_{Inrush_MPD} at the MPI.
PON: The MPD current at the MPI is limited by P_{MPD}.
DISABLED: The MPD presents $I_{MPD\_Disabled}$ at the MPI.

present_mismatch_indication
Controls presenting an indication that an MPD type is mismatched to the MPSE type on the mixing segment
Values:
FALSE: The MPD does not indicate a type mismatch
TRUE: The MPD indicates a type mismatch

present_mpi_power
Values: FALSE: The MPD is disabled or not ready to consume full power from the MPI
TRUE: The MPD is enabled and ready to consume full power from the MPI

present_tps
Controls applying the transmit power signature TPS (see Table 169–9) to the MPI.
Values: FALSE: The TPS is not to be applied to the MPI.
TRUE: The TPS is to be applied to the MPI.

V_{MPD}
Voltage at the MPD MPI (see Table 169–8).

169.5.3.4 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.

inrush_timer
: A timer used to prevent full load power draw while the MPD is in the inrush state. See T_{Inrush} in Table 169–8 for duration.

mark_timer
: A timer used to hold off inrush of an MPD during the mark state. See T_{Mark} in Table 169–8 for duration.

169.5.3.5 State diagrams

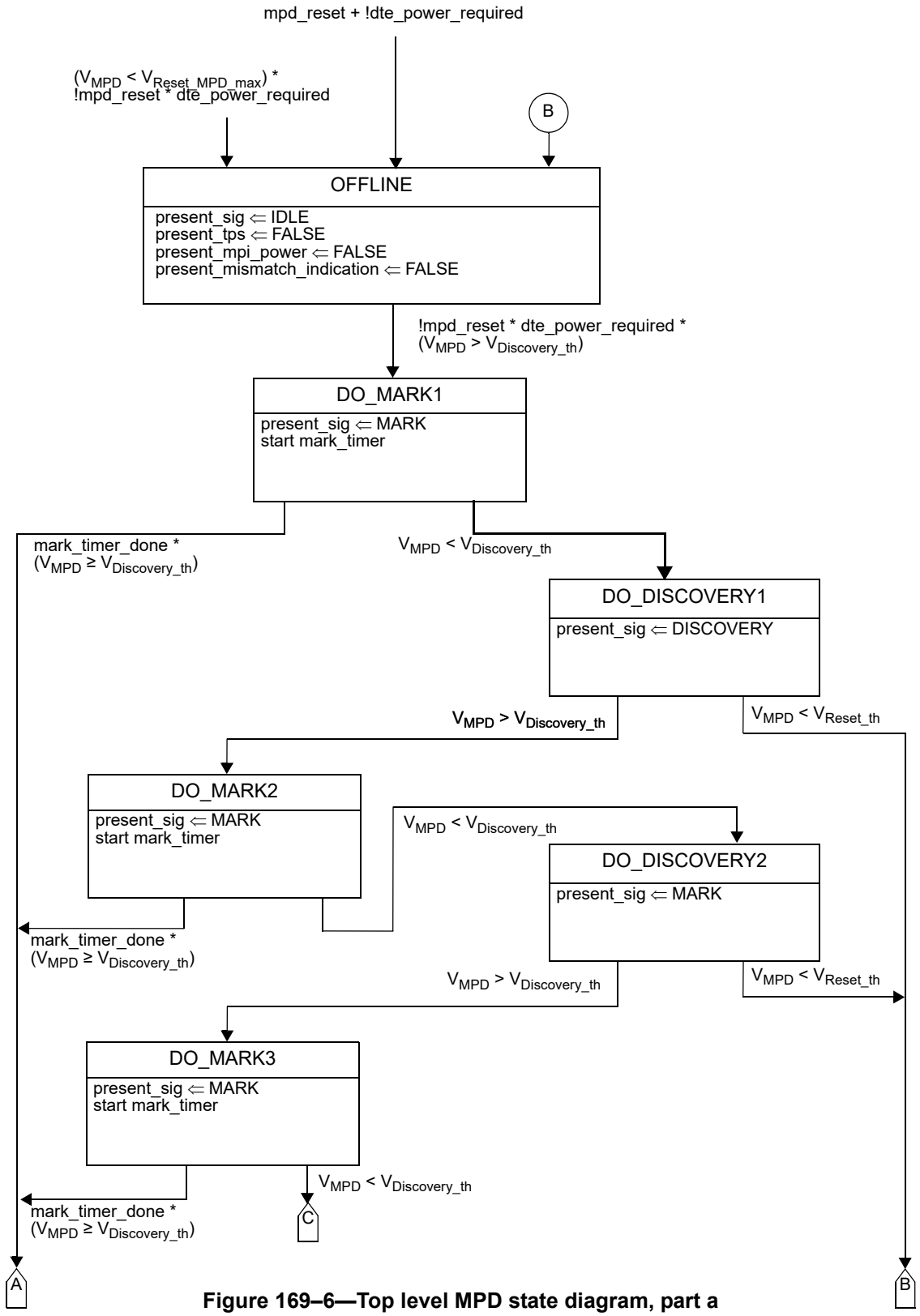

Figure 169–6—Top level MPD state diagram, part a

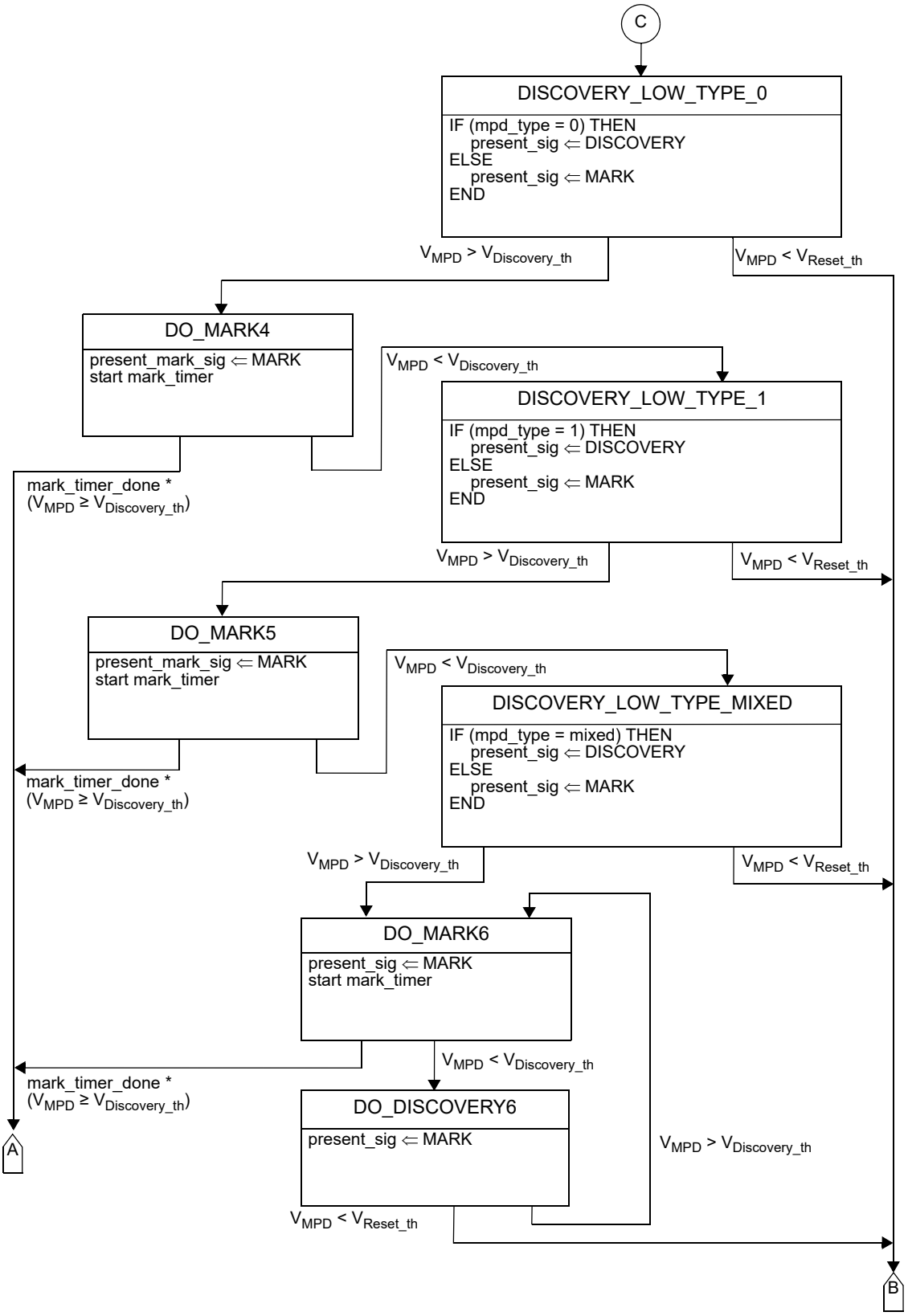

Figure 169–7—Top level MPD state diagram continued, part b

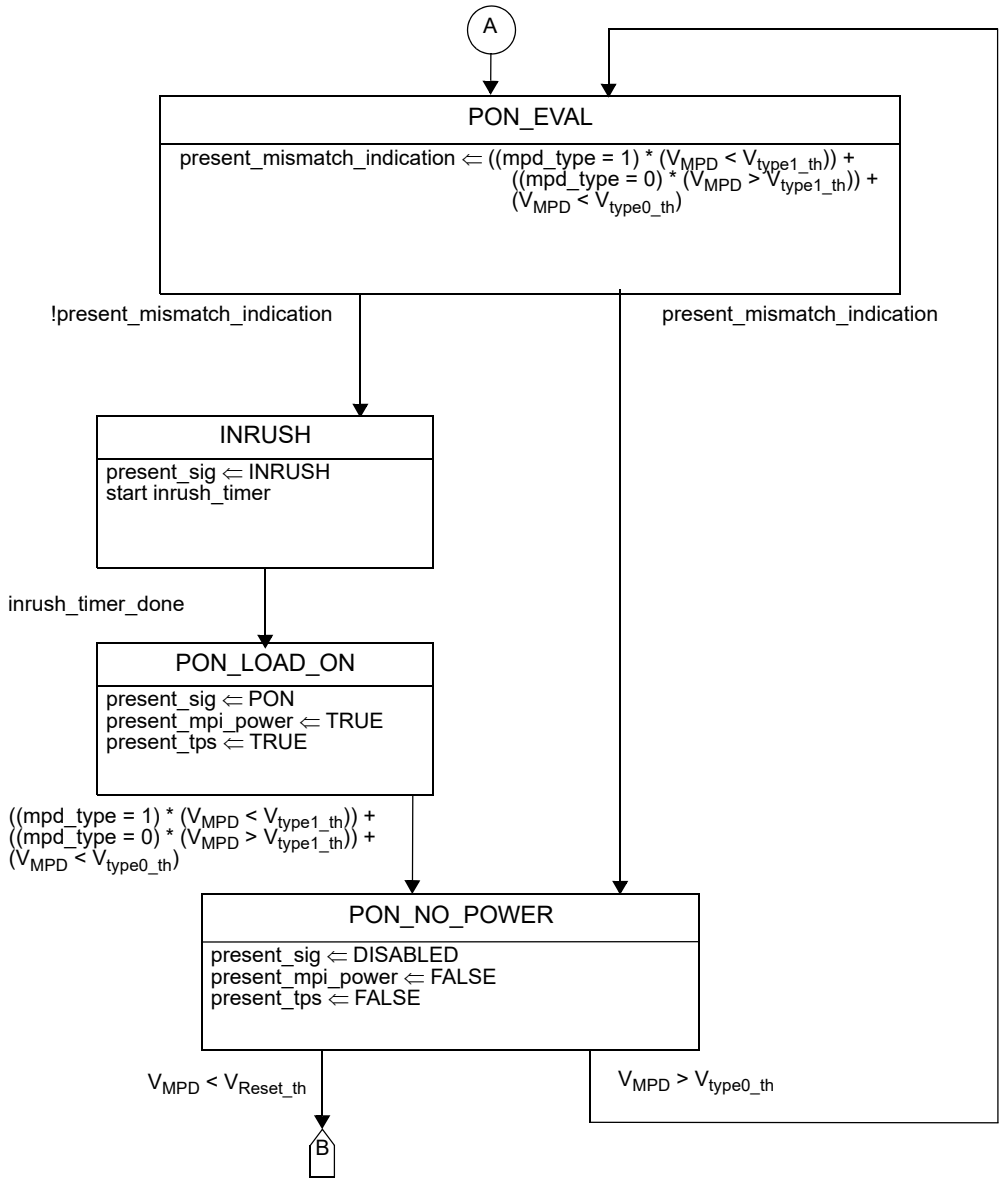

Figure 169–8—Top level MPD state diagram continued, part c

169.5.4 MPD discovery

When the MPD is presenting a mark event signature in a DO_MARKx state, as shown in the state diagram of Figure 169–6, Figure 169–7, and Figure 169–8, the MPD shall draw I_{MPD_mark} as defined in Table 169–7 within T_{MPD_mark} after entering the state.

The MPD shall not exceed the I_{MPD_mark} current limits when voltage at the MPI enters the V_{MPD_mark} specification as defined in Table 169–7.

The MPD enters a DO_DISCOVERYx state, as shown in the state diagram of Figure 169–6, Figure 169–7, and Figure 169–8, when the MPI voltage transitions from V_{MPD_mark} to $V_{MPD\_discover}$, crossing the threshold $V_{Discovery\_th}$.

When the MPD enters a DO_DISCOVERYx state and present_sig is DISCOVERY, the MPD shall draw $I_{MPD\_discover}$ within $T_{MPD\_discover}$ after entering the state.

When the MPD enters a DO_DISCOVERYx state and present_sig is MARK, the MPD shall draw I_{MPD_mark} within $T_{MPD\_discover}$ after entering the state.

Table 169–7—MPD discovery parameters

Item	Parameter	Symbol	Min	Max	Units	Additional Information
1	Mark event voltage	V_{MPD_mark}	16	19.1	V	
2	Mark discovery threshold	$V_{Discovery\_th}$	11.9	16	V	
3	Discovery event voltage	$V_{MPD\_discover}$	6.9	11.9	V	
4	Mark event current	I_{MPD_mark}	100	200	µA	
5	Discovery event current	$I_{MPD\_discover}$	1	2	mA	
6	Discovery reset threshold	V_{MPD_reset}	2.8	6.9	V	
7	MPD discovery stability time	$T_{MPD\_discover}$	—	6	ms	
8	MPD mark stability time	T_{MPD_mark}	—	3	ms	
9	Input capacitance outside of PON_-LOAD-ON state	$C_{MPD\_discover}$	5	12	nF	2.7V to 19.1V
10	IDLE and OFFLINE event current	I_{MPD_idle}	—	200	µA	

169.5.5 MPD power

The power supply of the MPD shall operate within the characteristics in Table 169–8. The MPD may be capable of drawing power from a local power source. When a local power source is provided, the MPD may draw some, none, or all of its power from the MPI.

Table 169–8—MPD power supply limits

Item	Parameter	Symbol	Unit	Min	Max	Type	Additional Information
1	Input voltage	VPort_MPD	V	16	30	0	
				34	50	1	
2	Unit power	P_{MPD_1U}	W		1	0	1 unit load
					2	1	1 unit load
3	Unit loading	N_{unit}	-	1	16	ALL	Must be an integer
4	Input power	P_{MPD}	W	1	16	0	N_{unit} * P_{MPD_1U}
				2	32	1	
5	Inrush current	I_{Inrush_MPD}	A	—	.01	ALL	
6	MPD Type 0 Voltage threshold	V_{type0_th}	V	11.9	16	ALL	
7	MPD Type 1 Voltage threshold	V_{type1_th}	V	30.1	34	ALL	
8	Mark Timer duration	T_{Mark}	ms	50	75	ALL	
9	Inrush to operating state delay	T_{Inrush}	ms	50	75	ALL	
10	MPD MPI capacitance during POWER_ON	C_{Port}	µF	—	180	ALL	
11	MPD current when connected to incompatible MPSE type	$I_{MPD\_Disabled}$	mA	—	5	ALL	

169.5.5.1 MPD inrush and Power On

An MPD evaluates the MPSE system type when V_{MPD} is greater than V_{type0_th} and T_{Mark} time has elapsed. If V_{MPD} is greater than V_{type0_th}, the T_{Mark} time has elapsed, and the voltages at both MP1 and MP2 are in a range that is compatible with the MPD type, the MPD proceeds to the INRUSH state.

The inrush current is the initial current drawn by the MPD, which is used to charge C_{Port}. An MPD limits the inrush current below I_{Inrush_MPD} to allow for large values of C_{Port}. MPDs remain in inrush for T_{Inrush} time. After T_{Inrush} has elapsed the MPD may draw full operating power.

When it is connected to an incompatible system type, an MPD draws no more than $I_{MPD\_Disabled}$ and does not enter the INRUSH state. If V_{MPD} is greater than V_{type0_th}, the T_{Mark} time has elapsed, and V_{MPD} is not in a voltage range that is compatible with the MPD type, the MPD shall provide an active indication to the user that the MPD is connected to an incompatible MPSE. The method of active indication is left to the MPD implementor. Two examples would be a flashing LED or a message from a console port.

169.5.5.2 MPD unit load

MPDs consume integer units of load, known as "unit loads".

For Type 0 MPDs, one unit load represents 1W. For Type 1 MPDs, one unit load represents 2W.

A mixing segment can support up to 16 unit loads. Each MPD is allocated a minimum of 1 unit load and may consume no more than 16 unit loads. The MPD system type and unit load level should be clearly indicated so users can track loading on a mixing segment. The sum of unit loads on a mixing segment shall not exceed 16.

MPD unit load level shall be an integer indicating the maximum power required by the MPD, where $N_{unit} * P_{MPD\_1U}$ is greater than the MPD's power requirements for the MPD system type.

MPDs may draw power less than or equal to P_{MPD}, based on the unit load level indicated, after entering the PON_LOAD_ON state.

169.5.5.3 MPD transmit power signature (TPS)

The transmit power signature (TPS) is a minimum current waveform reported by an MPD which allows an MPD to minimize its power consumption while signaling the MPSE to continue transmitting power.

An MPD that requires power from the MPI shall report a valid TPS at the MPI. An MPD that does not report TPS may have its power removed within the limits of T_{TPSDO} as defined in Table 169–5. I_{MPI_TPS}, T_{TPS_MPD}, and T_{TPSDO_MPD}, are defined in Table 169–9.

TPS shall consist of current draw equal to or above I_{MPI_TPS} for a minimum duration of T_{TPS_MPD} followed by an optional TPS dropout for no longer than T_{TPS_MPD}.

Table 169–9—MPD transmit power signature (TPS) parameters

Item	Parameter	Symbol	Min	Max	Units	Additional Information
1	MPD MPI current	I_{MPI_TPS}	10	-	mA	
2	MPD TPS time	T_{TPS_MPD}	7	-	ms	
3	MPD TPS dropout period	T_{TPSDO_MPD}	-	310	ms	

169.6 Additional electrical specifications

This clause defines additional electrical specifications for a fully connected MPoE system (that is, MPSE, cabling, one or more MPDs, and related PHYs) and therefore to each element of such a system.