

LG Multi F HVAC Minimum Load Operation

LG Air Conditioning Technologies



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Proper understanding of equipment capability is important to ensure successful design, installation, and operation. It also helps with setting appropriate expectations. While inverter components can adjust across a range of operation, the equipment's capability may not be appropriate for every designed load. Statements like "it's an inverter, it will ramp down to match the load" are common throughout the industry, though may not be true depending on the particular application of the product. In addition to consideration of equipment operation at design conditions, it's essential for designers to evaluate the capability for equipment to "ramp down" and operate at low or minimum output.

First, it's important to understand the overall capacity range that's represented by the "Min~Rated~Max" capacity values cited in applicable product literature. The [LG Residential Light Commercial Applications Guide](#) (hyperlink embedded for convenience) includes a section that details equipment Min~Rated~Max capacity. Two main take-aways when reviewing the product's capacity, should be that the cited values are based on AHRI rated conditions (cited on the equipment AHRI certificate) and that "Min" represents the minimum capacity output while "Max" represents the maximum (full-load) capacity output. So, a design taking into consideration more favorable or severe temperature conditions, when compared with the AHRI conditions could result in a variance from cited Min and Max capacity values, just as the capacity based on design conditions may be different than the AHRI "rated" capacity, or the published nominal capacity. Additionally, it is worth noting that the LG RLC Applications Guide includes other helpful information that should be reviewed such as a section that includes considerations to avoid equipment oversizing.

In addition to the content published in the LG RLC Applications Guide, the following examples provide additional details that should help improve understanding of product operation at low or minimum capability.

For a single zone HVAC system, the Min~Rated~Max capacity range simply correlates to the equipment capacity range. A cited Min or Max capacity is based on the matching indoor unit (IDU) and outdoor unit (ODU) – so any variance between cited values and expected output would only be due to external factors, such as project design temperatures and applicable pipe derate. For example, a 24k Btu/h Long Pipe system cited with Min capacity of 3,070 Btu/h at AHRI conditions could have a slightly different Min capacity when compared to actual project design conditions (such as 100F outdoor temp, 77/64 indoor temp). Before accounting for any pipe derate, the capacity in this instance, based on project design conditions, would be 20,790 Btu/h compared to the AHRI conditions capacity of 22k Btu/h. This is an important factor that must be taken into consideration since the Min~Rated~Max capacity range is based on AHRI temperatures and other physical system variable defined in the AHRI Standard, but the project design capacity is 5.5% less than the AHRI Rated capacity. Although it may appear at first glance that a designer might correlate a similar 5.5% reduction to the AHRI rated Min capacity if evaluating equipment minimum operation (or similarly the maximum operation), this assumption may not be true.



Table 2: Single Zone Extended Piping Wall Mounted Specifications.

System (Model) (Indoor Unit / Outdoor Unit)	LS243HLV3 (LSN243HLV3/LSU243HLV3)
Cooling Capacity ¹ (Min./Rated/Max) (Btu/h)	3,070 ~ 22,000 ~ 30,000
Cooling Power Input ¹ (Rated) (kW)	1.69
Heating Capacity (Min./Rated/Max) (Btu/h)	3,070 ~ 26,000 ~ 36,200
Heating Power Input ¹ (Rated) (kW)	2.08

Cooling Capacity Table for LS243HLV3 (LSU243HLV3 + LSN243HLV3)

Table 11: LSN243HLV3 / LSU243HLV3 Cooling Capacities.

Outdoor Air Temp. (°F DB)	Indoor Air Temperature (°F DB / °F WB)																				
	64 / 53			68 / 57			72 / 61			77 / 64			80 / 67			86 / 72			90 / 75		
	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI	TC	SHC	PI
0	13.32	10.35	0.66	16.66	11.02	0.78	19.99	11.69	0.90	24.16	12.53	1.05	26.66	13.03	1.14	22.25	14.21	0.93	19.30	15.00	0.79
5	13.07	10.20	0.69	16.34	10.86	0.81	19.61	11.52	0.94	23.70	12.35	1.10	26.15	12.84	1.19	21.82	14.01	0.97	18.93	14.78	0.83
7	13.16	10.29	0.70	16.45	10.96	0.82	19.74	11.63	0.95	23.86	12.46	1.11	26.33	12.96	1.20	21.97	14.14	0.98	19.06	14.92	0.83
10	13.29	10.44	0.71	16.62	11.11	0.84	19.95	11.79	0.97	24.10	12.63	1.13	26.60	13.14	1.22	22.20	14.33	1.00	19.26	15.12	0.85
14	13.47	10.62	0.72	16.84	11.31	0.85	20.22	12.00	0.99	24.43	12.86	1.15	26.96	13.38	1.25	22.50	14.59	1.02	19.52	15.40	0.87
23	14.46	11.41	0.71	17.40	12.14	0.86	20.33	12.88	1.01	24.00	13.80	1.20	26.20	14.36	1.31	23.06	15.66	1.04	20.96	16.53	0.87
25	14.69	11.59	0.73	17.56	12.30	0.88	20.43	13.02	1.02	24.02	13.91	1.20	26.18	14.45	1.31	23.31	15.83	1.06	21.40	16.75	0.89
30	15.25	12.03	0.79	17.97	12.70	0.92	20.68	13.36	1.05	24.08	14.19	1.22	26.11	14.68	1.32	23.94	16.25	1.10	22.50	17.30	0.95
35	15.82	12.48	0.84	18.38	13.09	0.96	20.94	13.70	1.09	24.13	14.46	1.24	26.05	14.91	1.33	24.58	16.67	1.14	23.60	17.85	1.02
40	16.39	12.93	0.89	18.79	13.48	1.01	21.19	14.04	1.12	24.19	14.73	1.26	25.99	15.15	1.34	25.21	17.09	1.19	24.70	18.39	1.08
45	16.96	13.38	0.95	19.20	13.88	1.05	21.44	14.38	1.15	24.24	15.00	1.28	25.93	15.38	1.35	25.85	17.51	1.23	25.79	18.94	1.15
50	17.52	13.82	1.00	19.61	14.27	1.09	21.69	14.72	1.18	24.30	15.27	1.30	25.86	15.61	1.36	26.48	17.94	1.27	26.89	19.49	1.21
55	18.09	14.27	1.05	20.02	14.66	1.13	21.95	15.06	1.21	24.36	15.55	1.31	25.80	15.84	1.37	27.12	18.36	1.31	27.99	20.03	1.27
60	18.66	14.72	1.11	20.43	15.06	1.18	22.20	15.40	1.24	24.41	15.82	1.33	25.74	16.07	1.38	27.75	18.78	1.36	29.09	20.58	1.34
65	18.49	14.59	1.16	20.17	15.00	1.23	21.85	15.41	1.30	23.95	15.92	1.38	25.21	16.23	1.43	27.21	18.79	1.41	28.55	20.49	1.40
70	18.32	14.45	1.22	19.91	14.94	1.28	21.50	15.42	1.35	23.48	16.02	1.42	24.67	16.38	1.47	26.68	18.80	1.47	28.02	20.41	1.47
75	18.15	14.32	1.27	19.65	14.88	1.33	21.14	15.43	1.40	23.01	16.12	1.47	24.14	16.54	1.52	26.14	18.81	1.53	27.48	20.32	1.54
80	17.98	14.19	1.33	19.39	14.81	1.39	20.79	15.44	1.45	22.55	16.22	1.52	23.60	16.89	1.56	25.61	18.82	1.59	26.94	20.24	1.61
85	17.81	14.05	1.39	19.12	14.75	1.44	20.44	15.45	1.50	22.08	16.33	1.56	23.07	16.85	1.60	25.07	18.83	1.65	26.40	20.15	1.68
90	17.64	13.92	1.44	18.86	14.69	1.49	20.09	15.46	1.55	21.62	16.43	1.61	22.53	17.00	1.65	24.53	18.84	1.71	25.87	20.07	1.75
95	17.47	13.79	1.50	18.60	14.63	1.55	19.74	15.47	1.60	21.15	16.53	1.66	22.00	17.16	1.69	24.00	18.85	1.77	25.33	19.98	1.82
100	17.01	13.43	1.52	18.17	14.31	1.57	19.34	15.19	1.62	20.79	16.29	1.68	21.66	16.95	1.72	23.58	18.55	1.79	24.87	19.62	1.84
105	16.56	13.06	1.54	17.75	13.98	1.59	18.94	14.91	1.64	20.42	16.06	1.71	21.31	16.75	1.74	23.17	18.25	1.82	24.41	19.26	1.87
110	16.10	12.70	1.57	17.32	13.66	1.62	18.54	14.62	1.67	20.06	15.82	1.73	20.97	16.54	1.77	22.76	17.95	1.84	23.95	18.89	1.89
115	15.53	12.25	1.59	16.70	13.18	1.64	17.88	14.12	1.69	19.35	15.28	1.75	20.24	15.99	1.79	21.98	17.35	1.87	23.14	18.26	1.92
118	15.18	11.98	1.60	16.34	12.89	1.65	17.49	13.81	1.70	18.93	14.96	1.76	19.80	15.65	1.80	21.52	16.99	1.88	22.66	17.88	1.93

For example, consider a multi-zone product where the minimum capacity cited for a unit (c/o the Min~Rated~Max capacity cited in literature such as the Engineering Manual example below) may not be consistent with a specific project's combination. The LMU480HHV has a cited Min~Max capacity range of 10,800~58,000 Btu/h: the minimum 10,800 Btu/h capacity corresponds to the minimum possible combination for that outdoor unit (which is 18k Btu/h of connected indoor units/capacity). Similarly, the maximum 58,000 Btu/h capacity corresponds to the maximum possible combination for that outdoor unit (which is 65k Btu/h of connected indoor units/capacity). In this example, a Multi F unit designed to accommodate the minimum 18k Btu/h combination will not be able to demand the ODU's full-load Max capacity, and a Multi F unit designed to accommodate the maximum 65k Btu/h combination will not be able to unload to reach the Min capacity due to the capacity of the IDUs connected.

Table 17: Multi F MAX with LGRED Outdoor Unit Specifications.

Model Number	LMU361HHV	LMU421HHV	LMU480HHV
Capacity			
Cooling (Btu/h) (Min.~Rated~ Max.) ¹	10,800~36,000~47,000	10,800~42,000~53,000	10,800~48,000~58,000
Cooling Power Input (kW) (Min.~Rated~ Max.)	0.64~2.48~4.07	0.64~3.04~4.71	0.64~3.66~5.17
Cooling Running Current (A) (Min.~Rated~ Max.)	2.9~11.2~18.5	2.9~13.8~21.3	2.9~16.6~23.4
Heating (Btu/h) (Min.~Rated~ Max.) ¹	12,420~45,000~50,000	12,420~48,000~54,500	12,420~52,500~59,000
Heating Power Input (kW) (Min.~Rated~ Max.)	0.71~3.30~4.31	0.71~3.70~4.70	0.71~4.25~5.09
Heating Running Current (A) (Min.~Rated~ Max.)	3.2~14.9~19.5	3.2~16.8~21.3	3.2~20.0~23.0



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To properly evaluate an outdoor unit's minimum or maximum operation, it's important to first determine the appropriate minimum or maximum capacity associated with the specific project's IDU combination.

In the Multi F ODU Combination Data Manual Table 27 shown below, a unit with 36k Btu/h of connected indoor units/capacity has a specific and different "Min~Rated~Max" capacity range compared to the "overall" capacity range cited for the ODU. For example, a LMU480HHV with 36k Btu/h connection has a Min~Rated~Max capacity range of 21,600~36,000~39,686 Btu/h.

Table 27: LMU480HHV with Non-Ducted Indoor Units — Rated Cooling Combination Table.

Total Indoor Unit Capacity (kBtu/h)	Total Cooling Capacity						Input (W)			Running Current (W)			EER2	SEER2
	Minimum		Rated		Maximum		Min.	Rated	Max.	Min.	Rated	Max.		
	Btu/h	kW	Btu/h	kW	Btu/h	kW								
18	10,800	3.17	18,000	5.28	20,700	6.07	643	1,125	1,617	2.9	5.1	7.3	16.0	22.5
19	11,400	3.34	19,000	5.57	21,755	6.38	682	1,194	1,705	3.1	5.4	7.7	15.9	22.5
20	12,000	3.52	20,000	5.86	22,810	6.69	722	1,263	1,794	3.3	5.7	8.1	15.8	22.4
21	12,600	3.69	21,000	6.15	23,864	6.99	762	1,333	1,883	3.5	6.0	8.5	15.8	22.4
22	13,200	3.87	22,000	6.45	24,919	7.30	802	1,404	1,973	3.6	6.4	8.9	15.7	22.4
23	13,800	4.04	23,000	6.74	25,974	7.61	843	1,476	2,063	3.8	6.7	9.3	15.6	22.4
24	14,400	4.22	24,000	7.03	27,029	7.92	885	1,548	2,154	4.0	7.0	9.8	15.5	22.3
25	15,000	4.40	25,000	7.33	28,083	8.23	927	1,622	2,246	4.2	7.3	10.2	15.4	22.3
26	15,600	4.57	26,000	7.62	29,138	8.54	969	1,696	2,338	4.4	7.7	10.6	15.3	22.3
27	16,200	4.75	27,000	7.91	30,193	8.85	1,012	1,770	2,431	4.6	8.0	11.0	15.3	22.3
28	16,800	4.92	28,000	8.21	31,248	9.16	1,055	1,846	2,524	4.8	8.4	11.4	15.2	22.2
29	17,400	5.10	29,000	8.50	32,302	9.47	1,099	1,923	2,619	5.0	8.7	11.9	15.1	22.2
30	18,000	5.28	30,000	8.79	33,357	9.78	1,143	2,000	2,713	5.2	9.1	12.3	15.0	22.2
31	18,600	5.45	31,000	9.09	34,412	10.09	1,188	2,078	2,809	5.4	9.4	12.7	14.9	22.1
32	19,200	5.63	32,000	9.38	35,467	10.39	1,233	2,157	2,905	5.6	9.8	13.2	14.8	22.1
33	19,800	5.80	33,000	9.67	36,521	10.70	1,278	2,237	3,002	5.8	10.1	13.6	14.8	22.1
34	20,400	5.98	34,000	9.96	37,576	11.01	1,325	2,318	3,099	6.0	10.5	14.0	14.7	22.1
35	21,000	6.15	35,000	10.26	38,631	11.32	1,371	2,400	3,197	6.2	10.9	14.5	14.6	22.0
36	21,600	6.33	36,000	10.55	39,686	11.63	1,419	2,483	3,298	6.4	11.2	14.9	14.5	22.0
37	22,200	6.51	37,000	10.84	40,740	11.94	1,470	2,572	3,405	6.7	11.7	15.4	14.4	21.9
38	22,800	6.68	38,000	11.14	41,795	12.25	1,522	2,664	3,515	6.9	12.1	15.9	14.3	21.8
39	23,400	6.86	39,000	11.43	42,850	12.56	1,575	2,756	3,627	7.1	12.5	16.4	14.2	21.8
40	24,000	7.03	40,000	11.72	43,905	12.87	1,629	2,850	3,740	7.4	12.9	16.9	14.0	21.7
41	24,600	7.21	41,000	12.02	44,960	13.18	1,683	2,946	3,854	7.6	13.3	17.5	13.9	21.6
42	25,200	7.39	42,000	12.31	46,014	13.49	1,739	3,043	3,969	7.9	13.8	18.0	13.6	21.5
43	25,800	7.56	43,000	12.60	47,069	13.80	1,796	3,143	4,080	8.1	14.2	18.5	13.7	21.3
44	26,400	7.74	44,000	12.90	48,124	14.10	1,853	3,243	4,191	8.4	14.7	19.0	13.6	21.2
45	27,000	7.91	45,000	13.19	49,179	14.41	1,912	3,346	4,303	8.7	15.2	19.5	13.5	21.0
46	27,600	8.09	46,000	13.48	50,233	14.72	1,971	3,450	4,415	8.9	15.6	20.0	13.3	20.8
47	28,200	8.26	47,000	13.77	51,288	15.03	2,032	3,556	4,529	9.2	16.1	20.5	13.2	20.7
48	28,800	8.44	48,000	14.07	52,343	15.34	2,094	3,664	4,646	9.5	16.6	21.0	13.1	20.5
49	28,800	8.44	48,000	14.07	53,286	15.62	2,094	3,664	4,731	9.5	16.6	21.4	13.1	20.5
50	28,800	8.44	48,000	14.07	54,229	15.89	2,094	3,664	4,817	9.5	16.6	21.8	13.1	20.5
51	28,800	8.44	48,000	14.07	55,172	16.17	2,094	3,664	4,904	9.5	16.6	22.2	13.1	20.5
52	28,800	8.44	48,000	14.07	56,114	16.45	2,094	3,664	4,991	9.5	16.6	22.6	13.1	20.5
53	28,800	8.44	48,000	14.07	57,057	16.72	2,094	3,664	5,078	9.5	16.6	23.0	13.1	20.5
54	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
55	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
56	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
57	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
58	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
59	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
60	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
61	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
62	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
63	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
64	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5
65	28,800	8.44	48,000	14.07	58,000	17.00	2,094	3,664	5,165	9.5	16.6	23.4	13.1	20.5



The specified combination capacity range for a specific project is what the project designer should evaluate with respect to system design and equipment selection, especially if IDUs are each individually oversized for the load of the space load each serves.

Example: LMU480HHV with 36k Btu/h connected capacity from a combination of (3) 7k Btu/h IDUs and (1) 15k Btu/h IDU

Consider that the 7k Btu/h IDUs have a space load requirement of 5k Btu/h each while the 15k Btu/h IDU has a space load requirement of 13k Btu/h.

In the above example scenario, if minimum required demand were evaluated only for (2) of the 7k Btu/h IDUs – a total space load requirement of 10k Btu/h, the project designer could mistakenly presume that the LMU480HHV “overall” Min capacity of 10,800 Btu/h is adequate to satisfy the combined 10k Btu/h minimum space load for the (2) 7k Btu/h IDUs. However, due to the overall combination’s 36k Btu/h connected capacity, the actual Min capacity of the ODU would be 21,600 Btu/h – more than twice the required space load (resulting in more than twice the capacity required in each space). With no bypass capability in the ODU for excess capacity and because the Branch Distribution Unit EEVs are sized to accommodate up to a 24k Btu/h IDU¹, the EEVs for the (2) 7k Btu/h IDUs would pulse open wider than required to simply satisfy IDU capacity, to accommodate the refrigerant flow from the compressor in order to maintain target suction pressure... in this example, half of 21,600 Btu/h Min capacity would go to each of the 7k Btu/h IDUs - 10,800 Btu/h each. Like the single zone example above, the Min or Max capacity obtained from Multi F ODU combination tables is based on AHRI temperatures, so at design conditions there may be a slight variance that can be evaluated similarly using Multi F ODU performance tables for the applicable combination.

Whether the Min~Max capacity range is determined by equipment limitation (required minimum refrigerant mass flow through the compressor or the compressor’s full-speed maximum capacity) or determined by logic based on equipment combination (connected IDUs in a Multi F system that may be large enough the compressor-based minimum is less than the connected combination minimum capacity, or may be small enough that the compressor-based maximum is more than the connected combination maximum capacity), it’s important that the designer understand how to determine and take into account which of these two conditions will determine the corrected Min or Max capacity based on the project’s equipment selection and local weather conditions. An accurate representation of product operation must be evaluated so that proper design adjustments can be made if necessary. For example, if small space loads drive the oversizing of IDUs (and the ODU), it may be advantageous to combine space loads so that they are accommodated by a single right-sized (ducted) IDU instead of multiple oversized IDUs. With low static, high static, and VAHU options there should be a solution available provided there is space to accommodate ductwork.

1. Port D on PMBD3641 accommodates a 36k Btu/h IDU; IDU connections on single-fan Multi F ODUs accommodate up to 24k Btu/h; RLC IDUs do not contain EEVs – they are in the ODU or BDU vs VRF IDUs that have an integrated EEV sized for that IDU

