

2

WIRING AND PROTECTION

(Excerpts from Chapter 2)

ARTICLE 210 BRANCH CIRCUITS

I. General Provisions

210.1 Scope

Article 210 applies to all branch circuits except motor loads. When a branch circuit supplies this type of load in combination with a motor load, both this article and Article 430 must be followed. When the branch circuit supplies only motor loads, Article 430 must be followed.

210.2 Other Articles for Specific-Purpose Branch Circuits

The rules for branch circuits in Table 210.2 amend or supplement this article as noted.

210.3 Rating

Branch circuits are rated according to the maximum permitted rating or setting of their overcurrent device. Generally, they are classified as 15, 20, 30, 40, and 50 A. There is an exception.

210.4 Multiwire Branch Circuits

Multiwire branch circuits are permitted. They can only supply line to neutral load, except if it supplies one piece of equipment or if all ungrounded conductors of the circuit are opened by the over-current device simultaneously.

210.5 Identification for Branch Circuits

In general, the grounded conductor must be identified in accordance with Section 200.6. The equipment grounding conductor must be identified in accordance with Section 250.119. If there are branch circuits being supplied at different voltage systems in premises, then all ungrounded conductors must be identified as to which voltage system they are on. The method of identification can be color coding, tagging, marking tape, or any other approved means. The identification must be posted permanently at the branch circuit distribution equipment.

210.6 Branch-Circuit Voltage Limitations

(A) The voltage between conductors cannot be greater than 120 V for lighting fixtures and cord-and-plug connected loads of less than 1440 VA or less than $\frac{1}{4}$ hp in dwelling units, hotel and motel guest rooms, guest suites, and the like.

(B) Circuits not exceeding 120 V to ground can supply auxiliary equipment of electric discharge lamps, utilization equipment, and terminals of lampholders within their voltage rating.

(C) Circuits between 120 and 277 V to ground can supply mogul-base screw-shell lampholders, lampholders used within their voltage rating, auxiliary equipment to electric discharge lamps, listed electric discharge fixtures, and utilization equipment. Additionally, these circuits can supply listed lampholders that are supplied at 120 V or less from a stepdown autotransformer which is part of the fixture and the outer shell terminal is connected to the grounded conductor of the branch circuit.

(D) 600 V between conductors.

(E) Over 600 Volts between conductors.

210.7 Branch Circuit Receptacle Requirements

(A) Receptacle Outlet Location. The location of receptacle outlets in branch circuits must be as noted in Part III of Article 210.

(B) Multiple Branch Circuits. If more than one device or equipment on the same yoke is supplied by more than one

branch circuit then a means must be provided at the panelboard where the branch circuits originate to simultaneously disconnect the ungrounded conductors supplying those receptacles.

210.8 Ground-Fault Circuit-Interruptor Protection for Personnel

(A) Dwelling Units. All 125-V single-phase 15- and 20-A receptacles must have ground fault protection for personnel when installed in bathrooms, garages and at or below grade level parts of storage or work areas and similar use in accessory buildings (two exceptions), outdoors (one exception), crawl spaces at or below grade level, unfinished basements (two exceptions), kitchens where the receptacles are serving counter tops, and laundry, utility, and wet bar sinks where the receptacle is within 1.8 m (6 ft.) of the outside edge of the sink and to serve the counter top. There are exceptions.

(B) Other than Dwelling Units. Ground-fault circuit interrupter receptacles are required in bathrooms, commercial and institutional kitchens, on rooftops, and outdoors in public spaces and outdoors where complying with 210.63 on all 125-V single-phase 15- and 20-A outlets. There is an exception.

(C) Boat Hoists. Ground-fault protection for personnel must be installed where power is provided for boat hoists in dwelling units that are supplied by 125-volt, 15- and 20-ampere branch circuits.

TABLE 210.2 Specific-Purpose Branch Circuits

	<i>Article</i>	<i>Section</i>
Air-Conditioning and Refrigerating Equipment		440.6 440.31 440.32 368
Busways		
Circuits and Equipment Operating at Less than 50 Volts	720	422.12
Central Heating Equipment Other than Fixed Electric Space Heating Equipment		
Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits	725	
Closed-Loop and Programmed Power Distribution Systems	780	
Cranes and Hoists		610.42 600.6
Electric Signs and Outline Lighting		
Electric Welders	630	
Elevators, Dumbwaiters, Escalators, Moving Walks, Wheelchair Lifts, and Stairway Chair Lifts		620.61
Fire Alarm Systems	760	
Fixed Electric Heating Equipment for Pipelines and Vessels		427.4
Fixed Electric Space Heating Equipment		424.3
Fixed Outdoor Electric De-icing and Snow-Melting Equipment		426.4
Information Technology Equipment		645.5
Infrared Lamp Industrial Heating Equipment		422.48, 424.3

Induction and Dielectric Heating Equipment	665	
Marinas and Boatyards		555.19
Mobile Homes, Manufactured Homes, and Mobile Home Parks	550	
Motion Picture and Television Studios and Similar Locations	530	
Motors, Motor Circuits, and Controllers	430	
Pipe Organs		650.7
Recreational Vehicles and Recreational Vehicle Parks	551	
Sound-Recording and Similar Equipment		640.8
Switchboards and Panelboards		408.32
Theaters, Audience Areas of Motion Picture and Television Studios, and Similar Locations		520.41
		520.52
		520.62
		660.2
		517.73
X-Ray Equipment		

ARTICLE 220 BRANCH-CIRCUIT, FEEDER, AND SERVICE CALCULATIONS

I. General

220.1 Scope

Figure 220.1 indicates the location in this section of the various calculation requirements.

220.3 Application of other Articles

Table 220.3 lists additional load calculation references for specialized areas.

220.5 Calculations

The nominal voltages to be used for branch-circuit and feeder load calculations are 120, 120/240, 208Y/120, 240, 347,

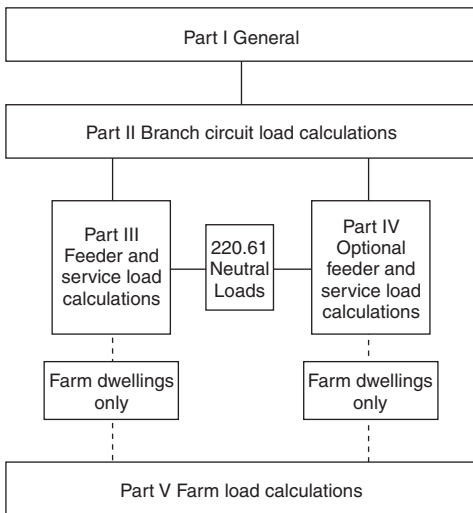


Figure 220.1 Branch-circuit, feeder, and service calculation methods.

**TABLE 220.3 Additional Load Calculation
References**

<i>Calculation</i>	<i>Article</i>	<i>Section (or Part)</i>
Air-Conditioning and Refrigerating Equipment, Branch-Circuit Conductor Sizing	440	Part IV
Cranes and Hoists, Rating and Size of Conductors	610	610.14
Electric Welders, ampacity calculations	630	630.11, 630.31
Electrically Driven or Controlled Irrigation Machines	675	675.7(A), 675.22(A)
Electrolytic Cell Lines	668	668.3(C)
Electroplating, Branch-Circuit Conductor Sizing	669	669.5
Elevator Feeder Demand Factors	620	620.14
Fire Pumps, Voltage Drop (mandatory calculation)	695	695.7
Fixed Electric Heating Equipment for Piplines and Vessels, Branch-Circuit Sizing	427	427.4
Fixed Electric Space Heating Equipment, Branch-Circuit Sizing	424	424.3
Fixed Outdoor Electric Deicing and Snow-Melting Equipment, Branch-Circuit Sizing	426	426.4
Industrial Machinery, Supply Conductor Sizing	670	670.4(A)
Marinas and Boatyards, Feeder and Service Load Calculations	555	555.12
Mobile Homes, Manufactured Homes, and Mobile Home Parks, Total Load for Determining Power Supply	550	550.18(B)
Mobiles Homes, Manufactured Homes, and Mobile Home Parks, Allowable Demand Factors for Park Electrical Wiring Systems	550	550.31

**TABLE 220.3 Additional Load Calculation
References (continued)**

<i>Calculation</i>	<i>Article</i>	<i>Section (or Part)</i>
Motion Picture and Television Studios and Similar Locations— Sizing of Feeder Conductors for Television Studio Sets	530	530.19
Motors, Feeder Demand Factor	430	430.26
Motors, Multimotor and Combination-Load Equipment	430	430.25
Motors, Several Motors or a Motor(s) and Other Load(s)	430	430.24
Over 600 Volt Branch Circuit Calculations	210	210.19(B)
Over 600 Volt Feeder Calculations	215	215.2(B)
Phase Converters, Conductors	455	455.6
Recreational Vehicle Parks, Basis of Calculations	551	551.73(A)
Sensitive Electrical Equipment, Voltage Drop (mandatory calculation)	647	647.4(D)
Solar Photovoltaic Systems, Circuit Sizing and Current	690	690.8
Storage-Type Water Heaters	422	422.11(E)
Theaters, Stage Switchboard Feeders	520	520.27

480Y.277, and 600 unless there are others specified. If there is a fraction of an ampere left when making the calculations, then if the fraction is less than 0.5 it can be dropped.

II. Branch-Circuit Load Calculations

220.10 General

Sections 220.12, 220.14, and 220.16 are to be used for branch circuit calculations.

220.12 Lighting Load for Specified Occupancies

Table 220.12 lists the minimum load required based on floor

area, which is calculated using outside dimensions. Where an area cannot be used in dwelling units, garages, and open porches, it does not have to be included. It should be noted that these values are minimum load conditions and 100% power factor and may not provide sufficient capacity for the proposed installation.

220.14 Other Loads—All Occupancies

There is a list of requirements for all other loads. An outlet for an appliance or other specific load not covered below is to be calculated on the ampere rating of the appliance or load. The load for electric dryers is based on Section 220.54 and electric ranges and other cooking devices on Section 220.55. Motor loads are to be calculated in accordance with Sections 430.22, 430.24, and 440.6. Luminaires (lighting fixtures) are to be calculated based on the maximum volt-ampere rating of the equipment and lamps. Heavy-duty lampholders are calculated at a minimum of 600 VA. Sign and outdoor lighting is to be calculated at a minimum of 1200 VA for each branch circuit noted in Section 600.5(A). Show windows are calculated at 200 VA per linear foot of window or the unit load as noted elsewhere in this section. Multioutlet assemblies need only be counted as one outlet (180 VA) for each 1.5 m (5-ft.) length unless many appliances are used simultaneously. If appliances are used simultaneously, then each 1.5 m (1-ft.) length is calculated at 180 VA. The portion containing the receptacle outlets can be used for calculations. Receptacle outlets on one strap other than those covered by the calculations in Section 220.14(J) are calculated at 180 VA each. If a single piece of equipment has multiple receptacles, then each receptacle is to be calculated at not less than 90 VA. Receptacles noted in Sections 210.11(C)(1) and (2) are not bound by the previous two sentences. In dwelling occupancies all receptacle outlets as noted in Sections 210.11(C)(3), 210.52(E), 210.52(G), and 210.70(A) and (B) are included in the general lighting load calculations in Section 220.12. In a bank or office building use the larger of either the calculated load of 220.14(I) or 1 volt-ampere/ft². All other outlets are calculated at 180 VA.

**TABLE 220.12 General Lighting Loads
by Occupancies**

<i>Type of Occupancy</i>	<i>Unit Load</i>	
	<i>Volt-Amperes per Sq. Meter</i>	<i>Volt-Amperes per Sq. Ft.</i>
Armories and auditoriums	11	1
Banks	39 ^b	3½ ^b
Barber shops and beauty parlors	33	3
Churches	11	1
Clubs	22	2
Court rooms	22	2
Dwelling units ^a	33	3
Garages—commercial (storage)	6	½
Hospitals	22	2
Hotels and motels, including apartment houses without provisions for cooking by tenants ^a	22	2
Industrial commercial (loft) buildings	22	2
Lodge rooms	17	1½
Office buildings	39 ^b	3½ ^b
Restaurants	22	2
Schools	33	3
Stores	33	3
Warehouses (storage)	3	¼
In any of the above occupancies except one-family dwellings and individual dwelling units of two family and multi-family dwelling units:		
Assembly halls and auditoriums	11	1
Halls, corridors, closets, stairways	6	½
Storage spaces	3	¼

^aSee Section 220.14(J).^bSee Section 220.14(K).

ARTICLE 240 OVERCURRENT PROTECTION

I. General

240.1 Scope

Parts I through VII give requirements for circuits of up to 600 V. Part VIII covers supervised industrial installations up to 600 V. Part IX covers over 600 V.

240.2 Definitions

240.3 Other Articles

Table 240.3 refers to other articles in the Code which pertain to overcurrent protection for specific equipment and systems.

240.4 Protection of Conductors

For other than flexible cords and fixture wires, use ampacities specified in Section 310.15 when calculating overcurrent protection. There are a number of cases where this rule does not necessarily hold true with special requirements. Some of them are: power loss hazard; devices rated 800 amperes or less; devices rated over 800 amperes; tap conductors; motor-operated appliance circuit conductors; motor and motor control circuit conductors; phase converter supply conductors; air conditioning and refrigeration equipment circuit conductors; transformer secondary conductors; capacitor circuit conductors; electric welder circuit conductors; remote control signalling and power limited circuit conductors; and fire protective alarm system circuit conductors. Refer to the *NEC*[®] for a complete list and for other sections and articles that may be relevant.

TABLE 240.3 Other Articles

	<i>Article</i>
Air-Conditioning and Refrigerating Equipment	440
Appliances	422
Audio Signal Processing Amplification, and Reproduction Equipment	640
Branch Circuits	210
Busways	368
Capacitors	460
Class 1, Class 2, and Class 3 Remote-Control, Signaling, and Power-Limited Circuits	725
Closed-Loop and Programmed Power Distribution System	780
Cranes and Hoists	610
Electric Signs and Outline Lighting	600
Electric Welders	630
Electrolytic Cells	668
Elevators, Dumbwaiters, Escalators, Moving Walks, Wheel Chair Lifts, and Stairway Chair Lifts	620
Emergency Systems	700
Fire Alarm Signaling Systems	760
Fire Pumps	695
Fixed Electric Heating Equipment for Pipelines and Vessels	427
Fixed Electric Space Heating Equipment	424
Fixed Outdoor Electric De-icing and Snow-Melting Equipment	426
Generators	445
Health Care Facilities	517
Induction and Dielectric Heating Equipment	665
Industrial Machinery	670
Luminaires (lighting fixtures), Lampholders, and Lamps	410
Motion Picture and Television Studios and Similar Locations	530
Motors, Motor Circuits, and Controllers	430
Phase Converters	455
Pipe Organs	650
Places of Assembly	518

TABLE 240.3 Other Articles (continued)

	<i>Article</i>
Services	230
Solar Photovoltaic Systems	690
Switchboards and Panelboards	408
Theaters, Audience Areas of Motion Picture and Television Studios, and Similar Locations	520
Transformers and Transformer Vaults	450
X-Ray Equipment	660