

SECTION H — ELECTRICITY

H02 GENERATION, CONVERSION, OR DISTRIBUTION OF ELECTRIC POWER

H02P CONTROL OR REGULATION OF ELECTRIC MOTORS, GENERATORS, OR DYNAMO-ELECTRIC CONVERTERS; CONTROLLING TRANSFORMERS, REACTORS OR CHOKE COILS (structure of the starter, brake, or other control devices, see the relevant subclasses, e.g. mechanical brake F16D, mechanical speed regulator G05D, variable resistor H01C, starter switch H01H; systems for regulating electric or magnetic variables using transformers, reactors or choke coils G05F; arrangements structurally associated with motors, generators, dynamo-electric converters, transformers, reactors or choke coils, see the relevant subclasses, e.g. H01F, H02K; connection or control of one generator, transformer, reactor, choke coil, or dynamo-electric converter with regard to conjoint operation with similar or other source of supply H02J; control or regulation of static converters H02M) **[4]**

Note(s)

1. This subclass covers arrangements for starting, regulating, electronically commutating, braking, or otherwise controlling motors, generators, dynamo-electric converters, clutches, brakes, gears, transformers, reactors or choke coils, of the types classified in the relevant subclasses, e.g. H01F, H02K.
2. This subclass does not cover similar arrangements for the apparatus of the types classified in subclass H02N, which arrangements are covered by that subclass.
3. In this subclass, the following terms or expressions are used with the meanings indicated:
 - "control" means influencing a variable in any way, e.g. changing its direction or its value (including changing it to or from zero), maintaining it constant, limiting its range of variation;
 - "regulation" means maintaining a variable at a desired value, or within a desired range of values, by comparison of the actual value with the desired value.

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1/00 Arrangements for starting electric motors or dynamo-electric converters (starting of synchronous motors with electronic commutators H02P 6/20, H02P 6/22; starting dynamo-electric motors rotating step by step H02P 8/04; vector control H02P 21/00) [4, 2006.01]	1/06 • • • Manually-operated multi-position starters
1/02 • Details	1/08 • • • Manually-operated on/off switch controlling power-operated multi-position switch or impedances for starting a motor
1/04 • • Means for controlling progress of starting sequence in dependence upon time or upon current, speed, or other motor parameter	1/10 • • • Manually-operated on/off switch controlling relays or contactors operating sequentially for starting a motor (sequence determined by power-operated multi-position switch H02P 1/08)

- 1/12 • • • Switching devices centrifugally operated by the motor
- 1/14 • • • Pressure-sensitive resistors centrifugally operated by the motor
- 1/16 • for starting dynamo-electric motors or dynamo-electric converters
- 1/18 • • for starting an individual dc motor
- 1/20 • • • by progressive reduction of resistance in series with armature winding
- 1/22 • • • in either direction of rotation
- 1/24 • • for starting an individual ac commutator motor (starting of ac/dc commutator motors H02P 1/18)
- 1/26 • • for starting an individual polyphase induction motor
- 1/28 • • • by progressive increase of voltage applied to primary circuit of motor
- 1/30 • • • by progressive increase of frequency of supply to primary circuit of motor
- 1/32 • • • by star/delta switching
- 1/34 • • • by progressive reduction of impedance in secondary circuit
- 1/36 • • • • the impedance being a liquid resistance
- 1/38 • • • by pole-changing
- 1/40 • • • in either direction of rotation
- 1/42 • • for starting an individual single-phase induction motor
- 1/44 • • • by phase-splitting with a capacitor
- 1/46 • • for starting an individual synchronous motor
- 1/48 • • • by pole-changing
- 1/50 • • • by changing over from asynchronous to synchronous operation (H02P 1/48 takes precedence)
- 1/52 • • • by progressive increase of frequency of supply to motor
- 1/54 • • for starting two or more dynamo-electric motors
- 1/56 • • • simultaneously
- 1/58 • • • sequentially

3/00 Arrangements for stopping or slowing electric motors, generators, or dynamo-electric converters (stopping of synchronous motors with electronic commutators H02P 6/24; stopping dynamo-electric motors rotating step by step H02P 8/24; vector control H02P 21/00) [2, 4, 2006.01]

- 3/02 • Details
- 3/04 • • Means for stopping or slowing by a separate brake, e.g. friction brake, eddy-current brake (brakes F16D, H02K 49/00) [2]
- 3/06 • for stopping or slowing an individual dynamo-electric motor or dynamo-electric converter [2]
- 3/08 • • for stopping or slowing a dc motor [2]
- 3/10 • • • by reversal of supply connections
- 3/12 • • • by short-circuit or resistive braking
- 3/14 • • • by regenerative braking
- 3/16 • • • by combined electrical and mechanical braking
- 3/18 • • for stopping or slowing an ac motor [2]
- 3/20 • • • by reversal of phase sequence of connections to the motor
- 3/22 • • • by short-circuit or resistive braking
- 3/24 • • • by applying dc to the motor
- 3/26 • • • by combined electrical and mechanical braking

4/00 Arrangements specially adapted for regulating or controlling the speed or torque of electric motors that can be connected to two or more different voltage or current supplies (starting H02P 1/00; stopping or slowing H02P 3/00; vector control H02P 21/00) [2006.01]

5/00 Arrangements specially adapted for regulating or controlling the speed or torque of two or more electric motors (starting H02P 1/00; stopping or slowing H02P 3/00; vector control H02P 21/00) [1, 2006.01]

- 5/46 • for speed regulation of two or more dynamo-electric motors in relation to one another
- 5/48 • • by comparing mechanical values representing the speeds
- 5/50 • • by comparing electrical values representing the speeds
- 5/52 • • additionally providing control of relative angular displacement
- 5/60 • controlling combinations of dc and ac dynamo-electric motors (H02P 5/46 takes precedence) [2006.01]
- 5/68 • controlling two or more dc dynamo-electric motors (H02P 5/46, H02P 5/60 take precedence) [2006.01]
- 5/685 • • electrically connected in series, i.e. carrying the same current [2006.01]
- 5/69 • • mechanically coupled by gearing [2006.01]
- 5/695 • • • Differential gearing [2006.01]
- 5/74 • controlling two or more ac dynamo-electric motors (H02P 5/46, H02P 5/60 take precedence) [2006.01]
- 5/747 • • mechanically coupled by gearing [2006.01]
- 5/753 • • • Differential gearing [2006.01]

6/00 Arrangements for controlling synchronous motors or other dynamo-electric motors with electronic commutators in dependence on the rotor position; Electronic commutators therefor (stepping motors H02P 8/00; vector control H02P 21/00) [3, 4, 6]

- 6/04 • Arrangements for controlling or regulating speed or torque of more than one motor [6]
- 6/06 • Arrangements for speed regulation of a single motor wherein the motor speed is measured and compared with a given physical value so as to adjust the motor speed [6]
- 6/08 • Arrangements for controlling the speed or torque of a single motor [6]
- 6/10 • • providing reduced torque ripple; controlling torque ripple [6]
- 6/12 • Monitoring commutation; Providing indication of commutation failure [6]
- 6/14 • Electronic commutators [6]
- 6/16 • • Circuit arrangements for detecting position (structural arrangement of position sensors H02K 29/06) [6]
- 6/18 • • • without separate position detecting element, e.g. using back-emf in windings [6]
- 6/20 • Arrangements for starting (H02P 6/08, H02P 6/22 take precedence) [6]
- 6/22 • Arrangements for starting in a selected direction of rotation [6]
- 6/24 • Arrangements for stopping [6]

7/00 Arrangements for regulating or controlling the speed or torque of electric dc-motors (starting H02P 1/00; stopping or slowing H02P 3/00; vector control H02P 21/00) [2, 2006.01]

- 7/06 • for regulating or controlling an individual dc dynamo-electric motor by varying field or armature current
- 7/08 • • by manual control without auxiliary power
- 7/10 • • • of motor field only
- 7/12 • • • • Switching field from series to shunt excitation or vice versa
- 7/14 • • • of voltage applied to the armature with or without control of field
- 7/18 • • by master control with auxiliary power
- 7/20 • • • using multi-position switch, e.g. drum, controlling motor circuit by means of relays (H02P 7/24, H02P 7/30 take precedence)
- 7/22 • • • using multi-position switch, e.g. drum, controlling motor circuit by means of pilot-motor-operated multi-position switch or pilot-motor-operated variable resistance (H02P 7/24, H02P 7/30 take precedence)
- 7/24 • • • using discharge tubes or semiconductor devices
- 7/26 • • • • using discharge tubes
- 7/28 • • • • using semiconductor devices
- 7/282 • • • • • controlling field supply only [4]
- 7/285 • • • • • controlling armature supply only [4]
- 7/288 • • • • • • using variable impedance [4]
- 7/29 • • • • • • using pulse modulation [4]
- 7/292 • • • • • • using static converters, e.g. ac to dc [4]
- 7/295 • • • • • • of the kind having one thyristor or the like in series with the power supply and the motor [4]
- 7/298 • • • • • controlling armature and field supply [4]
- 7/30 • • • using magnetic devices with controllable degree of saturation, i.e. transductors
- 7/32 • • • using armature-reaction-excited machines, e.g. metadyne, amplidyne, rototrol
- 7/34 • • • using Ward-Leonard arrangements

8/00 Arrangements for controlling dynamo-electric motors rotating step by step (vector control H02P 21/00) [2, 6, 2006.01]

- 8/02 • specially adapted for single-phase or bi-pole stepper motors, e.g. watch-motors, clock-motors [6]
- 8/04 • Arrangements for starting [6]
- 8/06 • • in selected direction of rotation [6]
- 8/08 • • Determining position before starting [6]
- 8/10 • • Shaping pulses for starting; Boosting current during starting [6]
- 8/12 • Control or stabilisation of current [6]
- 8/14 • Arrangements for controlling speed or speed and torque (H02P 8/12, H02P 8/22 take precedence) [6]
- 8/16 • • Reducing energy dissipated or supplied [6]
- 8/18 • • Shaping of pulses, e.g. to reduce torque ripple [6]
- 8/20 • • characterised by bidirectional operation [6]
- 8/22 • Control of step size; Intermediate stepping, e.g. micro-stepping [6]
- 8/24 • Arrangements for stopping (H02P 8/32 take precedence) [6]
- 8/26 • • Memorising final pulse when stopping [6]
- 8/28 • • Disconnecting power source when stopping [6]
- 8/30 • • Holding position when stopped [6]
- 8/32 • Reducing overshoot or oscillation, e.g. damping [6]
- 8/34 • Monitoring operation (H02P 8/36 takes precedence) [6]
- 8/36 • Protection against faults, e.g. against overheating, step-out; Indicating faults (emergency protective arrangements with automatic interruption of supply H02H 7/08) [6]

- 8/38 • • the fault being step-out [6]
- 8/40 • Special adaptations for controlling two or more stepping motors [6]
- 8/42 • characterised by non-stepper motors being operated step by step [6]

9/00 Arrangements for controlling electric generators for the purpose of obtaining a desired output (Ward-Leonard arrangements H02P 7/34; vector control H02P 21/00; feeding a network by two or more generators H02J; for charging batteries H02J 7/14) [1, 2006.01]

- 9/02 • Details
- 9/04 • Control effected upon non-electric prime mover and dependent upon electric output value of the generator (effecting control of the prime mover in general, see the relevant class for such prime mover) [2]
- 9/06 • Control effected upon clutch or other mechanical power transmission means and dependent upon electric output value of the generator (effecting control of the power transmission means, see the relevant class for such means) [2]
- 9/08 • Control of generator circuit during starting or stopping of driving means, e.g. for initiating excitation [2]
- 9/10 • Control effected upon generator excitation circuit to reduce harmful effects of overloads or transients, e.g. sudden application of load, sudden removal of load, sudden change of load [2]
- 9/12 • • for demagnetising; for reducing effects of remanence; for preventing pole reversal [2]
- 9/14 • by variation of field (H02P 9/08, H02P 9/10 take precedence) [2]
- 9/16 • • due to variation of ohmic resistance in field circuit, using resistances switched in or out of circuit step by step
- 9/18 • • • the switching being caused by a servomotor, measuring instrument, or relay
- 9/20 • • due to variation of continuously-variable ohmic resistance
- 9/22 • • • comprising carbon pile resistance
- 9/24 • • due to variation of make-to-break ratio of intermittently-operating contacts, e.g. using Tirrill regulator
- 9/26 • • using discharge tubes or semiconductor devices (H02P 9/34 takes precedence) [2]
- 9/28 • • • using discharge tubes
- 9/30 • • • using semiconductor devices
- 9/32 • • using magnetic devices with controllable degree of saturation (H02P 9/34 takes precedence) [2]
- 9/34 • • using magnetic devices with controllable degree of saturation in combination with controlled discharge tube or controlled semiconductor device
- 9/36 • • using armature-reaction-excited machines
- 9/38 • • Self-excitation by current derived from rectification of both output voltage and output current of generator
- 9/40 • by variation of reluctance of magnetic circuit of generator
- 9/42 • to obtain desired frequency without varying speed of the generator
- 9/44 • Control of frequency and voltage in predetermined relation, e.g. constant ratio
- 9/46 • Control of asynchronous generator by variation of capacitor
- 9/48 • Arrangements for obtaining a constant output value at varying speed of the generator, e.g. on vehicle (H02P 9/04-H02P 9/46 take precedence) [3]

H02P

- 11/00 Arrangements for controlling dynamo-electric converters** (starting H02P 1/00; stopping or slowing H02P 3/00; vector control H02P 21/00; feeding a network in conjunction with a generator or another converter H02J) **[4, 2006.01]**
- 11/04 • for controlling dynamo-electric converters having a dc output
- 11/06 • for controlling dynamo-electric converters having an ac output
- 13/00 Arrangements for controlling transformers, reactors or choke coils, for the purpose of obtaining a desired output** (regulation systems using transformers, reactors or choke coils G05F; transformers H01F; feeding a network in conjunction with a generator or a converter H02J; control or regulation of converters H02M) **[4]**
- 13/06 • by tap-changing; by rearranging interconnections of windings
- 13/08 • by sliding current collector along winding
- 13/10 • by moving core, coil winding, or shield, e.g. by induction regulator
- 13/12 • by varying magnetic bias
- 15/00 Arrangements for controlling dynamo-electric brakes or clutches** (controlling speed of dynamo-electric motors by means of a separate brake H02P 29/04, vector control H02P 21/00) **[1, 2006.01]**
- 15/02 • Conjoint control of brakes and clutches **[3]**
- 17/00 Arrangements for controlling dynamo-electric gears** (vector control H02P 21/00) **[3, 2006.01]**
- 21/00 Arrangements or methods for the control of electric machines by vector control, e.g. by control of field orientation [6, 2006.01]**
- Note(s) [2006.01]**
- When classifying in this group, it is desirable to also classify in groups H02P 25/00-H02P 27/00 if the kind of ac-motor, structural details, or the kind of supply voltage are of interest.
- 21/02 • specially adapted for optimising the efficiency at low load **[2006.01]**
- 21/04 • specially adapted for very low speeds **[2006.01]**
- 21/05 • specially adapted for damping motor oscillations, e.g. for reducing hunting **[2006.01]**
- 21/06 • Rotor flux based control **[2006.01]**
- 21/08 • • Indirect field-oriented control, e.g. field phase angle calculation based on rotor voltage equation by adding slip frequency and speed proportional frequency **[2006.01]**
- 21/10 • • Direct field-oriented control **[2006.01]**
- 21/12 • Stator flux based control **[2006.01]**
- 21/13 • Observer control, e.g. using Luenberger observers or Kalman filters **[2006.01]**
- 21/14 • Estimation or adaptation of machine parameters, e.g. rotor time constant, flux, speed, current or voltage **[2006.01]**
- 23/00 Arrangements or methods for the control of ac-motors characterised by a control method other than vector control** (starting H02P 1/00; stopping or slowing H02P 3/00; of two or more motors H02P 5/00; of synchronous motors with electronic commutators H02P 6/00; of dc-motors H02P 7/00; of stepping motors H02P 8/00) **[2006.01]**

Note(s) [2006.01]

When classifying in this group, it is desirable to also classify in groups H02P 25/00-H02P 27/00 if the kind of ac-motor, structural details, or the kind of supply voltage are of interest.

- 23/02 • specially adapted for optimising the efficiency at low load **[2006.01]**
- 23/03 • specially adapted for very low speeds **[2006.01]**
- 23/04 • specially adapted for damping motor oscillations, e.g. for reducing hunting **[2006.01]**
- 23/06 • Controlling the motor in four quadrants **[2006.01]**
- 23/08 • Controlling based on slip frequency, e.g. adding slip frequency and speed proportional frequency **[2006.01]**
- 23/10 • Controlling by adding a dc current (dc current braking H02P 3/24) **[2006.01]**
- 23/12 • Observer control, e.g. using Luenberger observers or Kalman filters **[2006.01]**
- 23/14 • Estimation or adaptation of motor parameters, e.g. rotor time constant, flux, speed, current or voltage **[2006.01]**
- 25/00 Arrangements or methods for the control of ac-motors characterised by the kind of ac-motor or by structural details** (starting H02P 1/00; stopping or slowing H02P 3/00; of two or more motors H02P 5/00; of synchronous motors with electronic commutators H02P 6/00; of dc-motors H02P 7/00; of stepping motors H02P 8/00) **[2006.01]**
- Note(s) [2006.01]**
- When classifying in this group, it is desirable to also classify in groups H02P 21/00, H02P 23/00 or H02P 27/00 if the control method or the kind of supply voltage are of interest.
- 25/02 • characterised by the kind of motor **[2006.01]**
- 25/04 • • Single phase motors, e.g. capacitor motors **[2006.01]**
- 25/06 • • Linear motors **[2006.01]**
- 25/08 • • Reluctance motors **[2006.01]**
- 25/10 • • Commutator motors, e.g. repulsion motors **[2006.01]**
- 25/12 • • • with shiftable brushes **[2006.01]**
- 25/14 • • • Universal motors (H02P 25/12 takes precedence) **[2006.01]**
- 25/16 • characterised by the circuit arrangement or by the kind of wiring **[2006.01]**
- 25/18 • • with arrangements for switching the windings, e.g. with mechanical switches or relays **[2006.01]**
- 25/20 • • • for pole-changing **[2006.01]**
- 25/22 • • Multiple windings; Windings for more than three phases **[2006.01]**
- 25/24 • • Variable impedance in stator or rotor circuit **[2006.01]**
- 25/26 • • • with arrangements for controlling secondary impedance **[2006.01]**
- 25/28 • • using magnetic devices with controllable degree of saturation, e.g. transducers **[2006.01]**
- 25/30 • • the motor being controlled by a control effected upon an ac generator supplying it **[2006.01]**
- 25/32 • • using discharge tubes **[2006.01]**

- 27/00 Arrangements or methods for the control of ac-motors characterised by the kind of supply voltage** (starting H02P 1/00; stopping or slowing H02P 3/00; of two or more motors H02P 5/00; of synchronous motors with electronic commutators H02P 6/00; of dc-motors H02P 7/00; of stepping motors H02P 8/00) **[2006.01]**
- Note(s) [2006.01]**
- When classifying in this group, it is desirable to also classify in groups H02P 21/00, H02P 23/00 or H02P 25/00 if the control method, the kind of the ac-motor or structural details are of interest.
- 27/02 • using supply voltage with constant frequency and variable amplitude **[2006.01]**
 - 27/04 • using variable-frequency supply voltage, e.g. inverter or converter supply voltage **[2006.01]**
 - 27/05 • • using ac supply for both rotor and stator circuits, the frequency of supply to at least one circuit being variable **[2006.01]**
 - 27/06 • • using dc to ac converters or inverters (H02P 27/05 takes precedence) **[2006.01]**
 - 27/08 • • • with pulse width modulation **[2006.01]**
 - 27/10 • • • using bang-bang controllers **[2006.01]**
 - 27/12 • • • • pulsing by guiding the flux-, current-, or voltage-vector on a circle or a closed curve, e.g. direct torque control **[2006.01]**
 - 27/14 • • • • with three or more levels of voltage **[2006.01]**
 - 27/16 • • using ac to ac converters without intermediate conversion to dc (H02P 27/05 takes precedence) **[2006.01]**
 - 27/18 • • • varying the frequency by omitting half waves **[2006.01]**
- 29/00 Arrangements for regulating or controlling electric motors, appropriate for both ac- and dc-motors** (starting H02P 1/00; stopping or slowing H02P 3/00; control of motors that can be connected to two or more different voltage or current supplies H02P 4/00; vector control H02P 21/00) **[2006.01]**
- 29/02 • Providing protection against overload without automatic interruption of supply, e.g. monitoring **[2006.01]**
 - 29/04 • by means of a separate brake **[2006.01]**
- 31/00 Arrangements for regulating or controlling electric motors not provided for in groups H02P 1/00-H02P 5/00, H02P 7/00 or H02P 21/00-H02P 29/00 [2006.01]**