# Table of Contents

**Section 1**  
**General Information** .............................................. 1–1  
  General Description .............................................. 1–1  
  Catalog Number .................................................. 1–1  
  Specifications .................................................... 1–2  
  Replacement SCR .................................................. 1–4  
  Replacement Fan ................................................... 1–4  
  Enclosures and Ventilation ....................................... 1–4  
  Warranty ............................................................ 1–4  
  Safety Notice ...................................................... 1–5  

**Section 2**  
**Installation** ..................................................... 2–1  
  Receiving and Storage ........................................... 2–1  
  Location and Mounting .......................................... 2–1  
  Wiring ............................................................... 2–1  

**Section 3**  
**Start–up and Operation** ......................................... 3–1  
  Start–Up Procedure .............................................. 3–1  
  Maintenance ....................................................... 3–1  
  Troubleshooting .................................................. 3–2  
  Operation .......................................................... 3–3  
  Schematic .......................................................... 3–4
Section 1
General Information

General Description
The single–phase starter reduces the starting current and torque of single–phase AC induction motors. The control uses solid–state circuitry and a bilateral SCR switch to gradually ramp up motor voltage over time during starting.

The single–phase starter is well suited for use with equipment such as crop dryers, augers, bucket elevators, and fan or pump applications. The need in these applications is to prevent high torque jerks and provide a smooth cushion, and at the same time apply a soft–start for a short duration.

Note: Motor loads that require full voltage starting torque to reach full speed may not be compatible for use with this control.

Catalog Number
The catalog number contains all the information necessary to determine the features of the unit. The complete five–digit catalog number appears on the invoice, packing list, and shipping carton. The catalog number on the control module and the panel will only have the digits necessary to define that part of the control.

How to read the catalog number

```
S 2 0 C A
```

- **Input Voltage**
  - 2=115/230V AC 50/60Hz

- **FLA Current Rating**
  - 0=7 Amps
  - 1=12 Amps
  - 2=24 Amps
  - 3=40 Amps
  - 5=110 Amps

- **Enclosure**
  - A=Open Form (chassis mopunt)
  - B=NEMA Type 1
  - C=NEMA Type 12
  - E=NEMA Type 3R

- **Configuration**
  - C=Single Phase

- **Type**
  - S=Single Phase Starter

Custom units are identified by the above 5 digit number plus a 3 digit extension. Documentation required for a custom unit is provided with the control and is not included in this manual.
### Specifications

#### Input Ratings

<table>
<thead>
<tr>
<th></th>
<th>S20CA</th>
<th>S21CA</th>
<th>S22CA</th>
<th>S23CA</th>
<th>S25CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>50 / 60Hz ±5%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Voltage</td>
<td>±10% of rated voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Phase</td>
<td>Single Phase</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Output Ratings

<table>
<thead>
<tr>
<th></th>
<th>S20CA</th>
<th>S21CA</th>
<th>S22CA</th>
<th>S23CA</th>
<th>S25CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>HP Rating 115VAC</td>
<td>1/4hp</td>
<td>1/2hp</td>
<td>2hp</td>
<td>3hp</td>
<td>10hp</td>
</tr>
<tr>
<td>230VAC</td>
<td>3/4hp</td>
<td>2hp</td>
<td>3hp</td>
<td>7.5hp</td>
<td>- 2</td>
</tr>
<tr>
<td>Current Rating</td>
<td>7 Amp</td>
<td>12 Amp</td>
<td>24 Amp</td>
<td>40 Amp</td>
<td>110 Amp</td>
</tr>
<tr>
<td>Overload Rating</td>
<td>Continuous 115% of FLA; 400% for 30 Seconds at 3300 ft. (1000 Meters)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Derate</td>
<td>Derate 1% per 330 ft (100m) above 3300 ft. (1000 Meters)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Control Specifications

<table>
<thead>
<tr>
<th></th>
<th>S20CA</th>
<th>S21CA</th>
<th>S22CA</th>
<th>S23CA</th>
<th>S25CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control Method</td>
<td>2 SCRs in inverse parallel for full wave Voltage Control</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ramp Time</td>
<td>Adjustable 2 – 30 Seconds</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Initial Torque T1 &amp; T2</td>
<td>Adjustable 0 – 100% of Input Voltage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control Power</td>
<td>Requires 115 or 230 VAC ±10%; 6 VA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### SCR Specifications

<table>
<thead>
<tr>
<th></th>
<th>S20CA</th>
<th>S21CA</th>
<th>S22CA</th>
<th>S23CA</th>
<th>S25CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak Inverse Voltage</td>
<td>1200VAC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heat Loss</td>
<td>1.3 Watts per running Amp</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Protection</td>
<td>RC Snubber</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Ambient Specifications

<table>
<thead>
<tr>
<th></th>
<th>S20CA</th>
<th>S21CA</th>
<th>S22CA</th>
<th>S23CA</th>
<th>S25CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating</td>
<td>Enclosed 32 to 113°F (0–45°C); Open 32 to 122°F (0–50°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cooling</td>
<td>Convection</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Derate</td>
<td>Derate 1.5% per degree C (0.84°F) above 115°F (45°C)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: 1. UL listed and CSA certification pending
2. NEMA and NEC do not list motors this large. The S25CA is rated to 110 amps at full load.
Figure 1-1 Mounting Dimensions

<table>
<thead>
<tr>
<th>Rating</th>
<th>Size</th>
<th>Terminal</th>
<th>Wire Size</th>
<th>Torque LB-in</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-40</td>
<td>OPEN</td>
<td>A</td>
<td>2-14</td>
<td>120</td>
</tr>
<tr>
<td>110 AMPS</td>
<td>OPEN</td>
<td>B</td>
<td>12-22</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>8-14</td>
<td>45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Rating</th>
<th>Size</th>
<th>Terminal</th>
<th>Wire Size</th>
<th>Torque LB-in</th>
</tr>
</thead>
<tbody>
<tr>
<td>8-40</td>
<td>5(110 AMP)</td>
<td>A</td>
<td>2-14</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td></td>
<td>B</td>
<td>12-22</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>C</td>
<td>8-14</td>
<td>45</td>
</tr>
</tbody>
</table>
### Replacement SCR

<table>
<thead>
<tr>
<th>AMP</th>
<th>Size</th>
<th>Catalog Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>0</td>
<td>SCR0036</td>
</tr>
<tr>
<td>12</td>
<td>1</td>
<td>SCR0005</td>
</tr>
<tr>
<td>24</td>
<td>2</td>
<td>SCR0015</td>
</tr>
<tr>
<td>40</td>
<td>3</td>
<td>SCR0025</td>
</tr>
<tr>
<td>110</td>
<td>5</td>
<td>SCR0115</td>
</tr>
</tbody>
</table>

### Replacement Fan

<table>
<thead>
<tr>
<th>AMP</th>
<th>Size</th>
<th>Catalog Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>5</td>
<td>FAN0005</td>
</tr>
</tbody>
</table>

### Enclosures and Ventilation

The Single Phase Starter is available in open form chassis mount or in several standard NEMA type enclosures. The control will generate approximately 1.3 watts of heat per ampere of full load current during operation. All factory–supplied enclosures are designed to dissipate this heat under maximum specified operating conditions. If the Single Phase Starter is mounted in an enclosure not supplied by the factory, this generated heat must be taken into consideration.

#### Open Form

Single Phase Starter supplied as a chassis mounted component. The installer should provide a suitable electrical enclosure and give consideration to the heat generated by the control.

#### NEMA Type 1

Intended for indoor use primarily to provide a degree of protection against falling rain and sleet. Remains undamaged by the formation of ice on the enclosure.

#### NEMA Type 3R

Intended for outdoor use primarily to provide a degree of protection against falling rain and sleet. Remains undamaged by the formation of ice on the enclosure.

### Warranty

For a period of two (2) years from date of original purchase BALDOR will repair or replace without charge controls which our examination proves to be defective in material or workmanship. This warranty is valid if the unit has not been tampered with by unauthorized persons, misused, abused, or improperly installed and has been used in accordance with the instructions and/or ratings supplied. The warranty does not cover short–circuited output or shorted SCRs or other warranty or guarantee expressed or implied. BALDOR shall not be held responsible for any expense (including installation and removal), inconvenience, or consequential damage, including injury to any person or property caused by items of our manufacture or sale. (Some states do not allow the exclusion or limitation of incidental or consequential damages, so the above exclusion may not apply.) In any event, BALDOR’s total liability, under all circumstances, shall not exceed the full purchase price of the control. Claims for purchase price refunds, repairs, or replacements must be referred to BALDOR with all pertinent data as to the defect, the date purchased, the task performed by the control, and the problem encountered. Goods may be returned only with written notification including a BALDOR Return Authorization Number and any return shipments must be prepaid.
Safety Notice Precautions

⚠️ WARNING: Do not touch any circuit board, power device or electrical connection before you first ensure that power has been disconnected and there is no high voltage present from this equipment or other equipment to which it is connected. Electrical shock can cause serious or fatal injury.

⚠️ WARNING: Be sure that you are completely familiar with the safe operation of this equipment. This equipment may be connected to other machines that have rotating parts or parts that are controlled by this equipment. Improper use can cause serious or fatal injury.

⚠️ WARNING: Be sure all wiring complies with the National Electrical Code and all regional and local codes or CE Compliance. Improper wiring may cause a hazardous condition.

⚠️ WARNING: Be sure the system is properly grounded before applying power. Do not apply AC power before you ensure that grounds are connected. Electrical shock can cause serious or fatal injury.

⚠️ WARNING: Do not remove cover for at least five (5) minutes after AC power is disconnected to allow capacitors to discharge. Electrical shock can cause serious or fatal injury.

⚠️ WARNING: Improper operation may cause violent motion of the motor and driven equipment. Be certain that unexpected movement will not cause injury to personnel or damage to equipment.

⚠️ WARNING: Motor circuit may have high voltage present whenever AC power is applied, even when motor is not moving. Electrical shock can cause serious or fatal injury.

⚠️ WARNING: If a motor is driven mechanically, it may generate hazardous voltages that are conducted to its power input terminals. The enclosure must be grounded to prevent a possible shock hazard.

⚠️ WARNING: The user must provide an external hard-wired emergency stop circuit to disable the control in the event of an emergency.

Continued on next page.
⚠️ Caution: To prevent equipment damage, be certain that the input power has correctly sized protective devices installed as well as a power disconnect.

⚠️ Caution: Avoid locating the control immediately above or beside heat generating equipment, or directly below water or steam pipes.

⚠️ Caution: Avoid locating the control in the vicinity of corrosive substances or vapors, metal particles and dust.

⚠️ Caution: Suitable for use on a circuit capable of delivering not more than the RMS symmetrical short circuit amperes listed here at rated voltage.

<table>
<thead>
<tr>
<th>Horsepower</th>
<th>RMS Symmetrical Amperes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5–50</td>
<td>5,000</td>
</tr>
</tbody>
</table>

⚠️ Caution: Baldor recommends not using “Grounded Leg Delta” transformer power leads that may create ground loops and degrade system performance. Instead, we recommend using a four wire Wye.

⚠️ Caution: Logic signals are interruptible signals; these signals are removed when power is removed from the drive.

⚠️ Caution: The safe integration of the driver into a machine system is the responsibility of the machine designer. Be sure to comply with the local safety requirements at the place where the machine is to be used. In Europe this is the Machinery Directive, the ElectroMagnetic Compatibility Directive and the Low Voltage Directive. In the United States this is the National Electrical code and local codes.

⚠️ Caution: Controls must be installed inside an electrical cabinet that provides environmental control and protection. Installation information for the drive is provided in this manual. Motors and controlling devices that connect to the driver should have specifications compatible to the drive.

⚠️ Caution: Do not tin (solder) exposed wires. Solder contracts over time and may cause loose connections.
Receiving and Storage

Baldor Controls are thoroughly tested at the factory and carefully packaged for shipment. When you receive your control, there are several things you should do immediately.

1. Observe the condition of the shipping container and report any damage immediately to the commercial carrier that delivered your control.
2. Remove the control from the shipping container and remove all packing materials. The container and packing materials may be retained for future shipment.
3. Verify that the part number of the control you received is the same as the part number listed on your purchase order.
4. Inspect the control for external physical damage that may have been sustained during shipment and report any damage immediately to the commercial carrier that delivered your control.
5. If the control is to be stored, store in a clean dry environment, free from contaminates. The maximum ambient temperature should not exceed 140°F (60°C).

Location and Mounting

The location of the control is important. Installation should be in an area that is protected from direct sunlight, corrosives, harmful gases or liquids, dust, metallic particles, and vibration. Exposure to these can reduce the operating life and degrade performance of the control. Mount enclosure or chassis in a vertical position. Allow space for proper ventilation and dissipation of heat generated across the heat sinks. (Refer to Enclosures and Ventilation.) Mounting dimensions are shown in Section 1, Figure 1-1.

Wiring

Use UL connectors crimped with proper tools on all wires. Refer to Figure 2-1 to select the most applicable wiring configuration. Be sure to read all notes on the drawings. Refer to the standard wiring drawing for proper voltage selection, connections and typical starter wiring. Always tighten all wires to the proper torque requirement (see Section 1).

Switching Method

No Contactor

1. If no contactor is used, connect the Starter to L1 and the motor to L2.
2. Connect switched voltage to terminals 1 or 4.
3. Terminal 6 (reset) requires no connection.

Series Contactor

1. If a contactor is used, connect the Starter to the L2 contactor side.
2. A continuous voltage must be connected to terminals 1 and 4.
3. Terminal 6 (reset) requires no connection.

Auxiliary Contact Switching

1. The Starter can be switched by an auxiliary, normally closed contact.
2. A continuous voltage must be connected to terminals 1 and 4.
3. Connect the auxiliary, normally closed, contacts to terminal 5 and 6 (reset) on the Single Phase Starter. (This will cause the Single Phase Starter to begin ramping the moment the contactor is energized.)
See terminal tightening torques in Section 1.

NOTE: This type of starter does not provide an air gap disconnect and only controls one line to the motor. A contactor or starter must be used where an air gap disconnect is required for safety.

NOTE: Reversing can be done on certain types of single-phase motors. The Single Phase Starter does not control the reversing action. A separate contactor must be used in switching certain wires on single-phase motors.
Start-Up Procedure

Disconnect input power before wiring or servicing any equipment.

**Recommended Equipment**
- Volt-ohmmeter (VOM), 20,000 ohms per volts.
- Clamp on ammeter, able to measure 5 times motor full load current.
- Adjustment tool provided with Single Phase Control.

**Starting Adjustments**

The potentiometer adjustments located on the Single Phase Starter must be set by the user to match the starting characteristics of the motor load. These are not preset by the factory. The adjustments have a maximum span of 270 degrees. Use the adjustment wand provided and do not force adjustments beyond stops.

**Initial Starting Torque #1 – (T1) 0–100%** – Sets the beginning point of the ramp. Usually set to start motor rotation slowly at the moment of switching. This adjustment is enabled when terminals 5 to 7 (T2) are open.

**Initial Starting Torque #2 – (T2) 0 TO 100%** – Sets the beginning point of the ramp. This adjustment is enabled when terminals 5 to 7 (T2) is closed.

**Ramp Time – (A) 0–7 Seconds** – Sets the time to ramp from initial starting torque to full voltage. Usually set to accelerate motor to full speed in the minimum acceptable time.

**Load Adjustment Procedures**

1. Set initial Torques (T1 and T2) and Ramp Time adjustments fully counterclockwise.
2. Adjust initial Torque (T1) clockwise sufficiently to start the load slowly moving at the moment of switching.
3. Adjust Ramp Time clockwise to desired starting time.

**NOTE:** Reducing the starting current by one half will reduce the starting torque to approximately one quarter and take four times as long to reach full speed. In situations where overloads tend to trip because of long starting times, trips can be reduced by increasing the starting current and reducing the starting time.

**Maintenance**
The control should be checked at regular intervals. Disconnect power when performing any checking or maintenance.

- Check all connections for tightness and signs of overheating.
- Check for cracked or damaged insulators and terminal blocks.
- Clean and inspect heat sinks for damage. Make sure they have proper ventilation.
- Remove excessive dust and dirt by vacuuming. Power must be off. Do not use water or solvents.
Troubleshooting  In the event of trouble, disconnect all power to the control.

Preliminary Checks
1. Disconnect all power.
2. Check all connections for tightness and signs of overheating.
3. Check for cracked or damaged insulators and terminal blocks.
4. Verify that all control wiring is correct.
5. Are the proper heaters installed in the overload relay?

CHECKING FOR SHORTED SCR

Resistance Check
Disconnect all power. Use an ohmmeter to measure the resistance between the line and load terminals. Do not megger (high voltage insulation test) the starter.

Line to load – resistance should be greater than 10,000 ohms.

If a shorted SCR is detected, check for possible shorted connections, system grounds, or any other condition which might be causing the short. Replacement of SCR without determination of the cause of failure may result in repeated failures.

<table>
<thead>
<tr>
<th>Symptom</th>
<th>Probable Cause</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>Starter does nothing when button is pressed.</td>
<td>No line voltage. Overload relay switch open.</td>
<td>Restore line voltage. Reset overload or allow system to cool.</td>
</tr>
<tr>
<td>Starter does not accelerate motor to full speed (stalls).</td>
<td>Control voltage less than minimum operating voltage</td>
<td>Fix control voltage regulation.</td>
</tr>
<tr>
<td>Motor accelerates slowly.</td>
<td>Ramp time is set too long.</td>
<td>Adjust ramp time clockwise.</td>
</tr>
<tr>
<td>Motor accelerates too quickly.</td>
<td>Reset contact is not closed prior to start. Ramp time set too short. Control has shorted SCR.</td>
<td>Check auxiliary contacts on the control. Adjust ramp time (A). Perform SCR resistance check.</td>
</tr>
<tr>
<td>Motor is noisy or vibrates when starting.</td>
<td>Control voltage less than minimum operating voltage. Initial start torque too low. Reset contact closed during start. SCR not firing. Defective motor.</td>
<td>Fix control voltage regulation. Adjust torque clockwise. Check auxiliary contacts on contactor. Repair or replace control. Check motor for shorts, opens, or grounds.</td>
</tr>
<tr>
<td>Overload relay trips when starting.</td>
<td>Incorrect heater size. Loose or burned heater. Mechanical problems.</td>
<td>Check heater size. Tighten or replace heater. Check machinery for binding or excessive loading.</td>
</tr>
<tr>
<td>Erratic operation</td>
<td>Loose connection.</td>
<td>Check all connections.</td>
</tr>
</tbody>
</table>
Operation

Three potentiometer adjustments (T1 initial starting torque one, T2 initial starting torque two, and (A) ramp time), allow the user to adapt the Single Phase Starter to the starting characteristics of the motor and load to minimize mechanical stress to equipment.

- Dual Initial Starting Torque: (T1 AND T2) adjustable from 0 to 100%.
- Ramp Time: (A) adjustable from 0 to 30 seconds.

By using switching contacts at terminals 5 and 7 you can switch from the T1 initial starting torque to the T2 initial torque setting. T1 is enabled when terminals 5 to 7 on the Single Phase Starter are open, T2 is enabled when 5 to 7 are closed. This may be used to accommodate different loads that require a different initial starting torque.

Ramp time is adjustable from 0 to 30 seconds and sets the time from the initial starting torque level of T1 or T2 to full load torque. The actual starting time is dependent on the Single Phase Starter adjustments and the motor load. Because the speed leads the torque, the motor will reach full speed in less time than the maximum setting on (A); the motor reaches full speed before it reaches full torque.
Schematic

3–4 Start–up and Operation

MN834