



Service Manual

GE SX Controls

For use with E7000–E12000 and EC35N–EC55N
Chassis Service Manual.

SENB8473-02

Features of SX Family of Transistor Motor Controllers

Standard Operation

With the accelerator at maximum ohms or volts, the creep speed can be adjusted by Function 2 of the Handset or a trimpot. The field control section allows the adjustment of the field weakening level in order to set the top speed of the motor. This top speed function (Minimum Field Current) is enabled when the armature current is less than the value set by Function 24 and the accelerator pedal is fully depressed. Top Speed can be adjusted by Function 7 of the Handset or a trimpot.

The percent on-time has a range of approximately 0 to 100 percent. The SX controllers operate at a constant frequency and the percent on-time is controlled by the pulse width of the voltage / current applied to the motor circuits.

Creep Speed

With the accelerator at minimum volts, the creep speed can be adjusted by Function 2 of the Handset. At creep speed, the ON time can decrease to approximately 5%, with the OFF time at approximately 95%. At full transistor operation, this condition will be reversed (short OFF time, long ON time). This variation of ON and OFF time of the oscillator varies the voltage applied to the motor, thereby varying the speed of the motor for a given load.

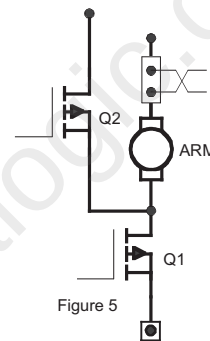
Control Acceleration

This feature allows for adjustment of the rate of time it takes for the control to accelerate to 100% applied battery voltage to the motor on hard acceleration. Armature C/A is adjusted by Function 3 from 0.1 to 22 seconds.

Current Limit

This circuit monitors motor current by utilizing sensors in series with the armature and field windings. The information detected by the sensor is fed back to the card so that current may be limited to a pre-set value. If heavy load currents are detected, this circuit overrides the oscillator and limits the average current to a value set by Function 4 and Function 8 of the Handset. The C/L setting is based on the maximum thermal rating of the control. Because of the flyback current through Q2, the motor current is usually greater than battery current, except at 100% ON time.

Regenerative Braking to Zero Speed



Slow down is accomplished when reversing direction by providing a small amount of torque for deceleration. If the vehicle is moving, and the directional lever is moved from one direction to the other, the regen signal is initiated. Once the regen signal has been initiated, the field current is increased (armature circuit shown in Figure 5). Armature

current is regulated to the regen current limit as set by Function 9. As the vehicle slows down, the field current continues to increase, and transistor Q2 begins to chop. The field current will increase until it reaches a preset value set by Function 10, and transistor Q2 on-time will increase until it reaches 100% on-time. Once both of the above conditions have been met, and regen current limit can no longer be maintained, the braking function is canceled. The fields will then reverse, and the control reverts back to motoring.

Part of the energy produced by the motor during regen is returned to the battery, and part is dumped in the motor as heat.

Pedal Position Regenerative Braking

This feature allows control of the stopping distance based on pedal position when there has been a "directional switch" change. Pedal position will reduce the regenerative current to as the accelerator is returned to the creep speed position. Maximum regenerative current is obtained with the accelerator in the top speed position.

PROGRAMMING

Function 49 - Mode 1 Regen Current Limit (Push CONT 2)

This function allows for the adjustment of the maximum current seen by the motor during regenerative braking; the higher the current, the shorter the stopping distance.

Volts	Min	Max	Set	Resolution Per unit value	Example If set at 220
36/48	182A	591A	0 to 255	1.625	344 amps

REGEN BRAKE $I_A = (\text{VAL} \times 1.625) + 182$ at 36/48 volts

This REGEN CURRENT LIMIT takes effect when the Mode 1 settings are called for by the Dash Display.

Function 50 - Mode 1 Auto Regen Current Limit (Push CONT 3)

This function allows for the adjustment of the braking torque applied when the start or directional switch is opened, and the counter EMF is above the setting of Function 5. A higher current correlates to a shorter stopping distance.

$$\text{Current} = (\text{Value of Setting} / 4) \times 6.5$$

Note, if the result is less than 52 amps, the control will default to 52 amps.

This AUTO REGEN CURRENT LIMIT takes effect when the Mode 1 settings are called for by the Dash Display.

Function 51 - Mode 1 Speed Limit (Push CONT 4)

This function allows for the adjustment of the motor speed limit (maximum battery volts to the motor).

Range	100% to 0% battery volts
Set	46 to 180
Resolution	0.75% per set unit
Example:	Setting of 80 = 75% of battery volts

$$\text{SPEED LIMIT} = 100\% - ((\text{VAL}-46) \times 0.75\%)$$

This speed limit takes effect when the Mode 1 settings are called for by the interactive Dash Display.

Function 52 - Mode 2 Armature Controlled Acceleration (Push CONT 5)

Same as Function 48.

This C/A takes effect when the Mode 2 settings are called for by the Dash Display.

Function 53 - Mode 2 Regen Current Limit (Push CONT 6)

Same as Function 49.

This REGEN CURRENT LIMIT takes effect when the Mode 2 settings are called for by the Dash Display.

Function 54 - Mode 2 Auto Regen Current Limit (Push CONT 7)

Same as Function 50.

This AUTO REGEN CURRENT LIMIT takes effect when the Mode 2 settings are called for by the Dash Display.

Function 55 - Mode 2 Speed Limit (Push CONT 8)

Same as Function 51.

This SPEED LIMIT 2 takes effect when the Mode 2 settings are called for by the Dash Display.

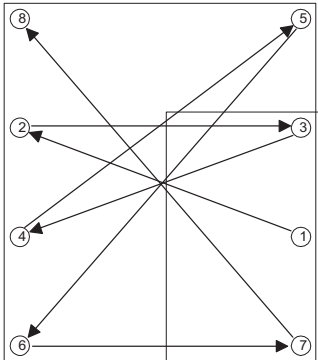
Function 56 - Mode 3 Armature Controlled Acceleration (Push CONT 9)

Same as Function 48.

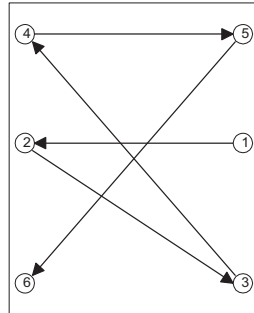
This C/A takes effect when the Mode 3 settings are called for by the Dash Display.

CHECKS AND REPAIRS

Traction



Hydraulic



Proper sequence for use in tightening hardware during control mounting

Maintenance

If it is necessary to remove the control, careful consideration must be given to removing the old thermal compound from the control and mounting surface, prior to replacement of the unit. Never re-use thermal compound. Use a putty knife or similar straight edge to carefully remove all thermal compound residue without damaging either mounting surface. Flush the surfaces with a liquid de-greaser or parts cleaner and allow them to dry, before re-applying the thermal compound and mounting the control. Take care not to contaminate the surfaces with hydraulic fluid or battery acid.

If the copper heat conducting pad between the control and the truck shows signs of corrosion that cannot be cleaned, then the copper pad must be replaced. Otherwise, carefully remove the old thermal compound and reapply it before installing the new control.

Table One - Failures That Cause Reduced or No Motor Torque (Continued)

NOTE

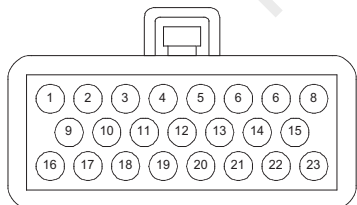
Conduct all testing with drive wheels raised off the floor.

Symptom	Probable Cause
1c. Line contact closes, truck doesn't move.	• Check power fuse at positive on control. Should be battery volts. If not, check power fuse by volt drop check across fuse. • Check for over temperature condition on traction motor or traction control. • Check voltage at A1 and A2, should be battery volts. If not, check motor cables and volts at A1 and A2 to locate open circuit. Check motor brushes for sticking. • Check F1 to F2 for open field circuit (loose connections). • Check for voltage on F1 and F2, it should increase and decrease by pressing accelerator and releasing. • Check voltage at P1-7. Should be 0.5 volts with accelerator at creep speed, increasing to 3.5 volts or more as the accelerator is pressed down to top speed. If P1-7 remains at about 0.5 or less volts, check start switch and accelerator potentiometer. • Check circuit from accelerator start switch and potentiometer to traction control for open wires. • Check motor A1 to A2 for open circuit in motor armature. • Check motor F1 to F2 for open circuit in motor fields. • Check for direction switch inputs to control at P1-5 and P1-6 for forward and reverse. If voltage not present, check circuit to accelerator. Positive at P7-A and check for circuit through switch at P7-B and P7-C. • Replace the SX Traction control.

ELECTRICAL

Connections to Main Traction Plug P5 with Controller Hydraulics

Pin	Wire	COLOR	PUMP INPUT/OUTPUT	NORMAL	ACTIVE	TEST PROCEDURE
1	2A	Blue	Battery volts from battery	B +	B +	Plug in battery
2	10A	Yellow	Battery volts from key	0 volts	B +	Key switch on
3	-	-	Blank			
4	-	-	Blank			
5	85	Blue/White	BWI Traction Motor	0 volts		Brushes worn
6	86	Yellow/White	BWI Traction Motor	0 volts		Brushes worn
7	-	-	Blank			
8	87	Violet/White	BWI Pump	0 volts		Brushes worn
9	88	Green/White	BWI Pump	0 volts		Brushes worn
10	17	Black/White	Hyd. Enable signal	12 volts	0 volts	Low Battery (lift cutout) Seat switch closed
11	82	Red/White	Pump Temperature	5 volts	0 volts	Over Temp light on
12	52	Yellow/Blue	Pump Aux 1 & 2 Switch	5 volts	0 volts	Handle pulled (switch closed)
13	24	Green/Yellow	To Plug 2 – 8	5 volts		
14	23	Green/Black	To Plug 2 – 9	5 Volts		
15	-	-	Blank			
16	80	Brown/White	Traction Temperature	5 Volts	0 Volts	Over temp light on
17	18	Black/Red	To Plug 10 – 6			
18	-	-	Blank			
19	53	Yellow/Black	Hyd lift Switch # 2	5 Volts	0 Volts	Pull lift lever full (High Speed lift)
20	51	Yellow/Green	Tilt Switch	5 Volts	0 Volts	Push tilt lever
21	54	Yellow/Red	Hyd lift Switch #1	5 Volts	0 Volts	Pull lift lever back (Low speed lift)
22	-	-	Blank			
23	-	-	Blank			



WIRE HARNESS VIEW- MAIN PLUG

DIAGNOSTIC STATUS CODES

TRACTION STATUS CODE -44	DESCRIPTION OF STATUS Armature transistor did not turn off properly.	CAUSE OF STATUS INDICATION This status code will be displayed when, during control operation, the armature transistor fails to turn off. This will result in a PMT condition.
MEMORY RECALL YES Circuits valid for Traction Controller	CORRECTIVE ACTIONS SYMPTOM Line contactor opens and then can only be closed by opening and closing the key switch. POSSIBLE CAUSE Defective control. Replace controller unit.	TROUBLESHOOTING DIAGRAM
TRACTION STATUS CODE -45	DESCRIPTION OF STATUS Armature transistor did not turn on properly.	CAUSE OF STATUS INDICATION This status code will be displayed when, during control operation, the armature transistor fails to turn on properly. This will result in a PMT condition.
MEMORY RECALL YES Circuits valid for Traction Controller	CORRECTIVE ACTIONS SYMPTOM Truck will not operate. POSSIBLE CAUSE Defective control. Replace controller unit.	TROUBLESHOOTING DIAGRAM

Full Version Available

Caterpillar EC35N Forklift Control System Service Manual (SENB8473-02)

Caterpillar EC35N forklift control system service manual, covers ECU settings, wiring, fault codes, and diagnostics. Instant PDF download.

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