Table 3-3. Part list of the Converter Module.

Part code	Description
R14, V14	Charging circuit
V11, V12, V13	Rectifier bridge
A8	Input Protection Card SNAT 7902 INP (SNAT 7903 INP for 600 V units). This card contains gate trigger circuits for the rectifier thyristors together with capacitors and varistors to protect the bridge as well as the fuses to protect the fan.
L11, C14.1... C16.N, R11	DC-filter choke and capacitors, discharge resistors (AC choke on line side in 600 V units)
V1 ... V6	Inverter insulated gate bipolar transistors (IGBT).
V1C. ... V6C	Clamp diodes.
A3	Main Circuit Interface Card SNAT 7261 INT (SNAT 7266 INT for 600 V units). This card contains mainly the power supply, transistor gate trigger circuits, DC-voltage and motor current measurement circuits.
A4	Motor Control Card SNAT 7780 CNT.
A7	Matching Card SNAT xyzv SCL. A small card on top of SNAT 7261 INT containing the power range programming information for that particular SAMI hardware. (SNAT xyzv SCL, where xyz = kVA rating and v = 3 in 400 V units, v = 5 in 500 V units and v = 6 in 600 V units.)
U21, U22	Current transducers
Y61, (Y62)	Cooling fan(s) and associated transformer T61. **Note!** The transformer connection has to be made according to the actual supply voltage.
R7	The temperature of the heatsink is measured by means of R7. A thermostat (S1) is in series with it providing thermal protection for those components that are not covered by R7.
(V8, A9)	Optional braking chopper: consisting of a transistor and its control card SNAT 7800 BRC. The braking resistor is mounted outside the module. In MD cubicle versions it is mounted in the adjoining cubicle. For ratings of the braking chopper and resistor, see Section 12 - Options.
(A10, T10)	Optional Earth Fault Protection SNAT 7670 EFS with current transformer at the line side (T10). For settings, see Section 12 - Options.

Table 3-4. Part list of the Control Unit.

Part code	Description
A5	The Control Interface Card SNAT 7600/7640 contains the display and key-pad together with a terminal block, X50 for control wiring. RS 485 terminal block X51 and some programming jumpers for analogue inputs are on this card.
(A11, A12, A13)	Option cards: SNAT 7610 BAC, SNAT 7690 RS232/20 mA, SNAT 7520 IOE (see Section 12 - Options)

Table 3-5. Parts of the main circuit in enclosed versions of SAMI GS.

Part code	Description
Q1, F1.1... F1.3	Fuse load switch and fuses. The ratings of the fuses are given in Table 5-1.

Table 3-6. Optional parts in enclosed versions of SAMI GS.

Part code	Description
K1	Line contactor with three auxiliary contacts (1NC + 2NO). One of the NO auxiliary contacts is reserved for the contactor tripping circuit, the other contacts are connected to terminal block X1/18 - 21. With this option, control switch S01 (installed in the door), emergency stop switch S02 (installed in the door), transformer T1, circuit breaker F3 and fuses F2.1 and F2.2 are included. An input for external tripping of K1 is provided at terminals 3 and 4 of terminal block X1.
K2, F4	The terminals 2U2, 2V2, 2W2 and 2PE (terminal numbers 12 - 15 of terminal block X1) provide an auxiliary three-phase output (voltage U_1) for the cooling fan of a separately ventilated motor. Thermal switch F4 must be specified separately, according to the nominal current of the fan motor. The possible setting ranges are: 1) 1 ... 1.6 A 2) 1.6 ... 2.5 A 3) 2.5 ... 4 A 4) 4 ... 6 A Terminals 5 and 7 of terminal block X1 can be used for external control circuitry of K2 (it is suggested that one of the Relay Outputs (RO1..RO3) is programmed as RUN to control the fan of the seperately ventilated

Table 3-6 continues from page 13...

Part code	Description
	motor). **Note!** Tripping K1 leads to K2 tripping. The aux. contacts of K2 and F4 are connected to terminal block X1 / 8 - 11.
K3	Thermistor relay for motor thermal protection. The thermistors are connected to terminal block X1, terminals 26 and 27. The auxiliary contacts of K3 are connected to terminal block X1/22 - 25 (1 NC + 1 NO).
	The relay is self-resetting: Switch-OFF resistance 3 ± 0.6 kΩ, switch-ON resistance 0 ... 1.5 kΩ
R01	Cubicle heater equipped with a thermostat. This option requires an external 220 V/16 A supply at terminal block X1 terminals 28 and 29.
X2 the	Optional terminal block wired to the Control Interface Card SNAT 7600/7640 in Control Unit.
Y1	In IP 54 enclosed cabinets, there is an extra fan at the top of the cabinet to increase the pressure at the air inlet filters (also transformer T1, fuses F2.1 ... F2.2 and circuit breaker F3 are included in this option). Terminals 16 and 17 of terminal block X1 can be used for external control circuitry of Y1 (it is suggested that one of the Relay Outputs (RO1..RO3) is programmed as RUN, to control the fan of the separately ventilated motor).
X1	Terminal block for the above mentioned options. The terminals fit for 1.5 ... 4 mm^2 wires.

3.3 Functional Description of SAMI GS

Note! There is space for additional relays above terminal blocks.

(A14) RFI Filters to reduce electro-magnetic emission to nearby equipment (see Section 12 - Options).

Power-on sequence

When the line voltage is initially switched on, the capacitor bank is charged via the charging circuit. The charging takes less than one second. During this time, the thyristors of the rectifier bridge are not conducting.

Warning! The maximum permissible number of charges within one minute is four. If the DC-link is charged more often than this, the charging resistor may fail due to excessive heat. It is therefore not recommended to use the input contactor as a Start/Stop command for frequent duty cycles.

The power supply for the SAMI GS is fed from the capacitor bank.The power supply turns on, when the voltage on the capacitors reaches about 300 V. Subsequently, the Control Interface Card, Motor Control Card and Main Circuit Interface Card are energized.

When the DC-voltage has reached 80 % of its nominal value (see below), the processor on the Motor Control Card energizes the Input Protection Card. The thyristors are switched on, fully conducting, and the thyristor-diode rectifier behaves like a normal diode bridge.

The cooling fan also turns on at initial power-on. To prolong the useful life of the fan bearings, SAMI GS incorporates logic to turn the fan off after one minute, unless:

- the SAMI GS has got a RUN command, or
- the heatsink temperature is above 45°C

Normal duty, control

In normal duty the SAMI GS follows the commands and references given to it either from the keypad or terminal block on the Control Interface Card. The control signal source selection and the way SAMI GS interprets these signals are configured by parameters.

See Sections 6, Control Connections, 7, Control and Parameter Logic and 9, Drive Parameters (Group 11 Control Connections).

For drive related parameters, such as acceleration or deceleration times, start and stop modes, constant speeds, PI-controller values or output frequency, voltage and current limits, see Section 9, Drive Parameters (Groups 21 through 27).

Normal duty, main circuit

Power flow through a SAMI GS in normal duty is from AC-mains through the rectifier bridge to the DC-filter capacitors, which sustain a constant DC-voltage. The nominal value for this voltage is $1.35 * U_L$ (U_L actual line voltage).

The Inverter consists of 6 power semiconductor switches, whose operation is controlled by the Motor Control Card via the Main Circuit Interface Card. Turning these switches on and off in a certain sequence is called modulation. The modulation frequency in SAMI GS is about 3 kHz maximum.

The potential at any terminal U2, V2, W2 of the Inverter can only be high or low; the modulation determines which one. At any instant, the line to line output voltage is therefore either 0 V (when the switches in these phases are in the same position) or $+1.35 * U_L$ (when the corresponding switches are in different positions).

The output voltage wave-form is a pulse-train. The width of the pulses vary according to the modulation. The purpose of the modulation is to create the fundamental voltage wave (its amplitude and frequency), according to the law U_2/f_2 = constant.

The distortion of the output voltage from the sinusoidal fundamental creates corresponding harmonics in the motor current. However, since the motor is highly inductive and the modulation frequency is relatively high, the current wave-form is nearly sinusoidal.

Protective features

Should something adverse happen during power-up or normal duty, SAMI GS incorporates several protective features to protect itself:

- internal overtemperature (warning and trip)
- overcurrent (current limit and trip)
- mains phase loss/unbalance (trip)
- overvoltage (trip at 130 % nominal DC-voltage)
- undervoltage (trip at 65 % nominal DC-voltage)
- starting at overvoltage (>117 % of nominal DC-voltage inhibits start. See Section 10.5.)
- in addition various internal and external hardware faults are identified and a diagnostic message is given

SAMI GS also incorporates a variety of protective features for the motor, including:
- stall (warning and trip)
- overload (warning and trip)
- underload (warning and trip)

More information on these protective and diagnostic features can be found in Section 10, Fault Tracing. Some of them are selectable or programmable, see also Section 9, Drive Parameters (Group 31 Supervision, Group 32 Fault Function).

Power-off sequence

Warning! After the line voltage is disconnected, a high voltage remains on the capacitor bank, which is discharged through discharge resistors (R11) within five minutes.

4 Mechanical Installation

Always ensure by voltage measurement that the voltage has dropped before performing any service or making main circuit connections. (Measure between terminals UDC+ and UDC-. The meter must be capable of withstanding 1000 V DC.)

The dimensional drawings of the SAMI GS Converter Modules and Control Unit are in the Appendices 3 and 4, respectively. The dimensional drawings of SAMI GS in standard cabinet and MD cubicle are in Appendices 1 and 2, respectively. The weights given are approximate.

4.1 Cooling

SAMI GS frequency converters are provided with one (or two) cooling fan(s) on the bottom of the unit. In IP 54 units there is an additional fan at the top of the enclosure.

The maximum allowed ambient temperature (temperature of the air entering the unit) is 40 °C.

When installing the Control Unit in an enclosure, ensure that the temperature of the air surrounding the Control Unit does not exceed 50 °C.

The cooling air must be clean and free from corrosive agents (according to ISA-S71.04 G1). Where necessary the cooling air should be filtered.

For design purposes, the maximum total power losses, required cooling air volumes and free space requirements are tabulated below. The losses occur when the output current is I_{Nsq} and the input current I_{1sq}. The temperature rise of the cooling air with these air volumes and losses is below 18 °C.

400V Units	P W	Q_v m³/h	500V Units	P W	Q_v m³/h	Required free space [cm] to all directions outside the air inlets and outlets [1]
051-3-...	1500	300	061-5-...	1750	300	20
061-3-...	1750	570	071-5-...	2500	570	20
071-3-...	2500	570	100-5-...	3000	570	20
100-3-...	3000	690	120-5-...	3500	690	30
120-3-...	3500	690	140-5-...	4250	690	30
140-3-...	4250	1350	170-5-...	5250	1350	40
170-3-...	5250	1350	210-5-...	6500	1350	40
210-3-...	6500	1800	260-5-...	8000	1800	50
260-3-...	8000	1800	320-5-...	10000	1800	50
600 V Units			071-6	2800	570	-
			100-6	3300	690	-
			120-6	3900	1350	-
			170-6	5800	1800	-

[1] Only ACS 502 and ACS 503.

Table 4-1. Power losses, cooling air volumes and free space requirements of SAMI GS.

Note! When planning or inspecting the installation of a SAMI GS, pay special attention to the cooling air flow. Prevent the air from recirculating from the outlet of the unit back to the inlet. This is of special importance when installing an IP 00 module (ACS 504-..) in a cubicle, where careless lay-out and inadequate channelling may lead to recirculating air flow, and thus excessive temperature rise within the cubicle.

If the cooling air contains dust, clean the cooling surfaces of the unit regularly using compressed air and a brush. If there are filters at the air inlet of the enclosure, check their condition regularly and replace if needed.

If the cooling ability is reduced too much, the thermal protection of the SAMI GS operates causing a fault indication and stopping the frequency converter. The SAMI GS can be started again when the temperature of the heatsink has fallen below the tripping level (85°C).

The temperature of the heatsink can be read from the control panel display (Operating Data, parameter 8, SAMI TEMPERATURE).

The difference between the heatsink and ambient temperature is an indication of the prevailing cooling conditions, and can thus be utilised in preventive maintenance or in installation inspection. When the SAMI has been running at I_N for more than half an hour, the difference should be less than 25°C. When the SAMI has been running at I_{Nsq} (at f_2 50Hz) for more than half an hour, the difference should be less than 30°C.

4.2 Installing ACS 502 - ACS 503 Cabinets

The cabinet must be transported either on a pallet built under it or by the roof lifting lugs. The cubicle may be laid down on its back for moving through doors etc.

The cubicles are designed to be placed free standing on a level base or across a cable duct. The cubicle can be fastened to the base through the holes in the bottom by using 10 mm bolts. Weld mounting to the base cannot be used.

Whenever installing the ACS 502 - ACS 503 in cabinets take care that the required amount of cooling air is available in the installation room and the required free space round the cabinet is taken into account (see Table 4-1). Notice also the other requirements mentioned in Section 4.1.

The cubicles have to be installed with at least 150 mm free space in front of the air inlets and outlets.
Exception: The air outlets of ACS 503 on the back are allowed to be blocked (back to wall mounting).

Note! The ACS 502 types:
ACS 502-140-3 and 170-3
ACS 502-170-5 and 210-5
have air outlets on the right side (side to side mounting is not possible).

4.3 Installing ACS 504 Converter Module inside User Defined Cabinet

The converter takes in cooling air through the lower front of the module. The air intake must not be obstructed by any objects or structures. The converter module has to be installed into the cubicle with enough free

5 Power Connections

space round the module. The minimum dimensions are listed in Section 4.3 of separate manual Installing ACS 504 Converter Module inside User Defined Cabinet, which is one of the delivery documents. Notice also that the cooling air must not circulate inside the cubicle. (See the section 4.2 of the separate manual Installing ACS 504 Converter Module inside User Defined Cabinet).

5.1 Mains and Motor Cables

The cross sections for the cables can be determined according to the current values mentioned in Table 3-1. The maximum I^2t ratings for the input fuses to be used with the IP00 module can be found in Table 5-1 (ratings of the fuses in enclosed versions of the SAMI GS are equal to these). Screened cables are recommended as unscreened cables may lead to unwanted problems in electrical noise emission. Recommended tightening torque for the cable connections is 30 ... 44 Nm.

Note! Remove all the compensation capacitors form the line side so that they are not powered up at the same time as the SAMI GS.

Check that the supply capacity is adequate for the SAMI (P_N or P_{Nsq}). The short circuit power of the supply network must not exceed 20 MVA at the SAMI terminals, otherwise the clearing capacity of the input fuses may be

Type ACS 50X-...		Mains and motor terminals			Fuse Ratings		
400V	500V	U1, V1, W1	U2, V2, W2	PE	A	kA^2s	V
051-3-...	061-5-...	M10	M10	2*M10	125	16	660
061-3-...	071-5-...	M10	M10	2*M10	160	28	660
071-3-...	100-5-...	M10	M10	2*M10	200	28	660
100-3-...	120-5-...	M10	M10	2*M10	250	153	660
120-3-...	140-5-...	M10	M10	2*M10	315	186	660
140-3-...	170-5-...	M10	3*M12	2*M10	350	186	660
170-3-...	210-5-...	M10	3*M12	2*M10	400	471	660
210-3-...	260-5-...	M10	3*M12	2*M10	500	471	660
260-3-...	320-5-...	M10	3*M12	2*M10	630	471	660
600 V	071-6-...	M10	M10	2*M10	160	27	660
	100-6-...	M10	M10	2*M10	200	135	660
	120-6-...	M10	3*M12	2*M10	250	170	660
	170-6-...	M10	3*M12	2*M10	400	414	660

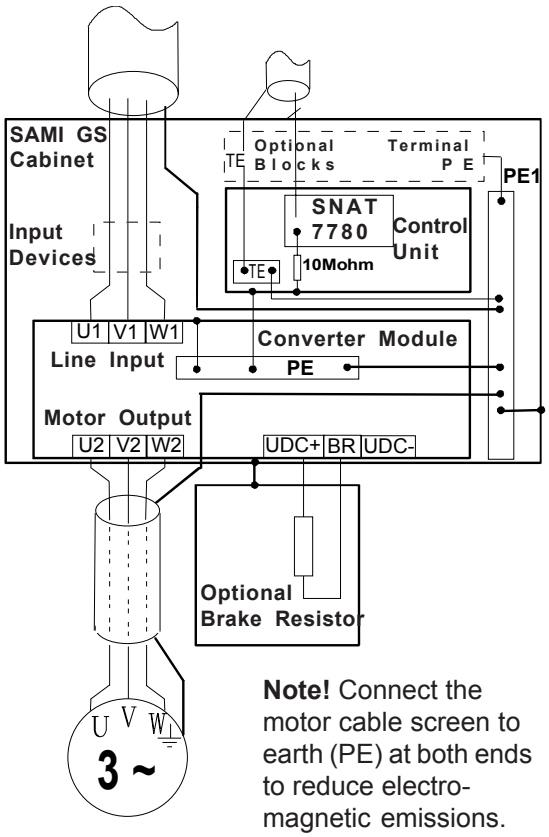
exceeded.

Connect the power connections in accordance with Figure 5-1 on page 20.
Note that the input fuses (in Table 5-1) to protect the frequency converter are of the ultra-fast type.

Examples of fuses are presented on page 2 of the separate manual Installing ACS 504 Converter Module inside User Defined Cabinet (for ACS 504 Converter Module).

Table 5-1. Terminal sizes and input fuse ratings.

CONTROL CABLING
Note! TE for cable screen is grounded. Ground the screen only at frequency converter end.



Note! Connect the motor cable screen to earth (PE) at both ends to reduce electromagnetic emissions.

Precautions with the Motor Cable

Install the motor cable away from other cable routes. Avoid parallel runs with other cables. If noise problems exist, contact ABB for more detailed information (see page 22).

Note! When retrofitting an existing motor with a SAMI GS, make sure that there is no other circuitry connected to the motor. For example, remove power factor correction capacitors.

Figure 5-1. Mains and motor connections.

Warning! The brake control terminals carry a dangerous DC voltage (>500 V). No device other than an ABB dynamic braking device may be connected to the UDC+, BR and UDC- terminals.

5.2 Insulation Checks

Note! Insulation checks must be performed before connecting the SAMI to the mains. Before proceeding with the insulation resistance measurements make sure that the SAMI is disconnected from the mains.

Do not make insulation checks on the SAMI GS, unless there is reason to suspect an isolation failure. Every unit has been tested for isolation between main circuit and chassis (2500 V rms for 1 minute) at the factory. A retest should not exceed 85 % of the original level under any circumstances.

Check that the motor cable is disconnected from the SAMI output on terminals U2, V2 and W2. Check that the motor cable is disconnected from the motor and remove bridging connections at the motor.

Measure the insulation resistances from the motor. The voltage range of the insulation resistance meter must be at least equal to the mains voltage, but not exceeding 1000 V. The insulation resistance must be greater than 1 MΩ.

Note! Do not connect the motor cable before proceeding with the Keypad control test without motor, see Section 8, Commissioning.

6 Control Connections

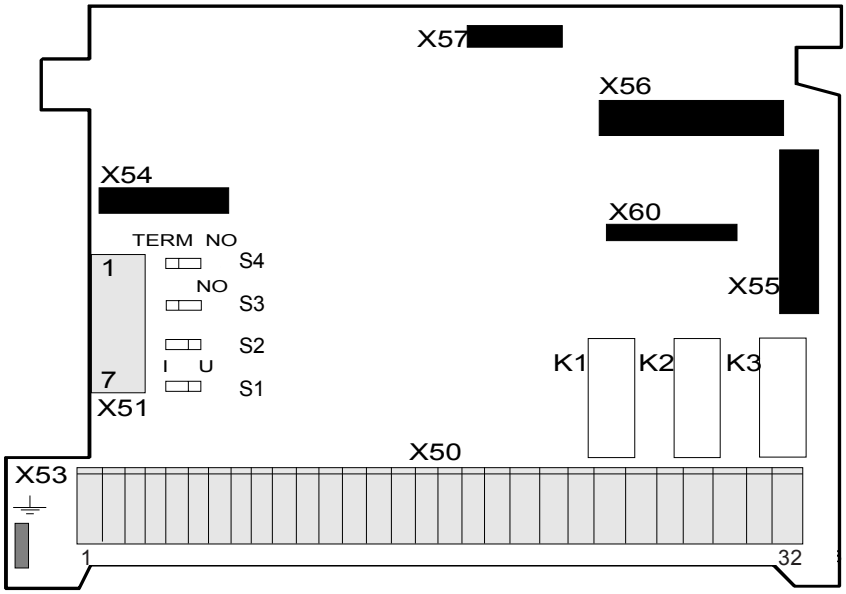


Figure 6-1. Control Interface Card SNAT 7640.

The Analogue Input signal selection is done with jumpers S1 (AI1) and S2 (AI2): I = 0(4) - 20 mA, V = 0(2) - 10 V.

X50 = screw terminal, X53 = earthing connector, X54 = connection to Motor Control Card, X55 and X56 = option card connectors.

X51 for RS 485 connection. Jumpers S3 and S4 are set to TERM in the last SAMI GS unit of a RS 485 chain.

The available control places for SAMI GS are:

a) Keypad (see Section 7, page 24)

b) The X50 screw terminal on the Control Interface Card SNAT 7600/7640 in the Control Unit (This terminal may have been routed to the optional Terminal Block X2 in the cabinet outside the Control Unit).

c) The RS 485 serial communication bus; terminal X51 on Control Interface Card (This terminal may have been routed to the optional Terminal Block X2 in the cabinet outside the Control Unit).

External control devices, for example a PLC or a remote control panel SACE 11 PAN, are connected to the screw terminal X50 according to the connection diagram of each Application Macro. The connection diagrams for Application Macros are presented in the Application Macro Manual.

The X50 connection diagram based on factory settings is presented in Section 6.2 on page 23. The terminal functions can be altered by means of parameter settings (refer to Section 9).

Some basic functions are selected by setting the jumpers on the Control Interface Card. Refer to Figure 6-1.

The Control Interface Card is accessible after removing the front cover of the Control Unit. To remove the cover, loosen slightly the four screws on the top and bottom of the cover.

6.1 Control Cables

Control cables for the SAMI GS should be 0.5 - 1.0 mm^2 screened, multi-core cables, if they are connected to the terminals on the Control Interface Card. Cables up to 4 mm^2 may be used if the optional Terminal Block X2 is used.

The the cable screens should be earthed at the TE terminal of the Control Unit.

When planning the cabling between the SAMI GS and an automation device, such as a PLC, attention should be given to interference suppression, signal levels, galvanic isolation, etc. The cables should be separated from the mains and motor cables and not running in parallel with them (minimum separation 300 mm if parallel run $\leq$ 10 m; add 300 mm for every 10 m). There should be no additional control components (contactors or relays) inside the SAMI GS and no control cables other than those of the SAMI GS.

The control connections of the SAMI GS are galvanically isolated from mains potential and have a 10 MΩ resistance from the inverter frame i.e. PE. Because of this, there is no need to connect X50/2,4,6 and 8 (logic GND) to TE or PE. However, if EMC problems occur it could prove useful to do this.

Analogue input and output signals:
A separate twisted pair must always be used for each individual signal.
Digital inputs:
It is strongly recommended to use screened cables for digital inputs (DI). An external + 24 V supply for the digital inputs (DI1 to DI6) must not be used.

Relay outputs:
If relay outputs (RO) operate on 24 V DC, the signals can be routed to the same cable used for the digital inputs. If twisted cables are used, digital output and input should never be in the same pair. If 110 V/230 V AC is connected to a relay output, a separate cable without screen can be used for these signals.

Note! If the relay outputs are used to control inductive loads (e.g. relays, contactors) they must be protected by using varistors or RC units (AC) or a diode (DC). The protection components should be installed onto the coil of the relay or contactor being controlled and not on the terminals of X50. When using an RC unit, the leakage current of the RC circuit must be less than the holding current of the controlled contactor or relay.