

## Analog I/O

The LCC controllers have one analog output and at least one analog input. The value of the analog inputs and outputs is expressed in counts.

### Control Version Specification

For various controller versions (both hardware and firmware versions) 1 or 2 analog inputs are available. The overview of the available analog I/O is shown in the table below.

Controller Analog I/O	Firmware version 1.x			Firmware version 2.x		
<b>LCC10 hardware version 1.0</b>	Input 1	0-5V	10 bit	Input 1	0-5V	<b>12 bit</b>
	Output	0-5V	10 bit	Output	0-5V	10 bit
<b>LCC10 hardware version 1.1</b>	Input 1	0-5V	10 bit	Input 1	0-5V	<b>12 bit</b>
	Input 2	-10..+10V	10 bit	Input 2	-10..+10V	<b>12 bit</b>
	Output	0-5V	10 bit	Output	0-5V	10 bit
<b>LCC11</b>	Input 1	0-5V	10 bit	Input 1	0-5V	<b>12 bit</b>
	Input 2	-10..+10V	10 bit	Input 2	-10..+10V	<b>12 bit</b>
	Output	0-10V	<b>16 bit</b>	Output	0-10V	<b>16 bit</b>

You can recognise the LCC10 by the serial number when connecting. The serial number starts with 27 followed by 7 digits. The LCC11 serial numbers start with 37 followed by 7 digits.

The range of counts for each voltage range is:

Voltage Range	Range in Counts
0-5V 10 bit	0... 1023 counts
0-5V 12 bit	0... 4095 counts
-10..+10V 10 bit	0... 1023 counts (0V = 511 counts)
-10..+10V 12 bit	0... 4095 counts (0V = 2047 counts)
0-10V 16 bit	0... 65535 counts

## Input Program Examples

You can use the analog input to copy the value to a register or use it as a source for the position profile.

### Analog Input → Register

To read the analog value (in counts) the object for the analog input can be used (0x12A03 for input 1, 0x22A03 for the optional input 2). The example below shows how the analog input 1 is used to set a target position. Since the position move has an empty Target, it will take the analog input value which is written into the target position register in the first line of the program sample.

2	3-1	SetVariable	Var=Target_position(0x00607A),Variable,Var1=Analog_inputs-Analog_input_1_value(0x012A03)	Target pos = analog input 1 value
2	3-2	PositionMove	Absolute,Target=,Vel=,Acc=,Change_immediate	

The analog input value can be copied similar to any other writable object. You can also do calculations with the analog input value.

### Analog Input → Reference Source for Position Profile

The analog input can also be used to directly update the demand position by setting it up to be the source for the position profile. An example is shown in the program sample below.

0		MacroNumber	1	Set up Analog Source Mode
1	1-1	SetVariable	Var=Analog_input_cmd_source-Analog_input_used(0x012434),Constant,Const=1	Select analog input nr to use
1	1-2	SetVariable	Var=Software_position_limit-Min_position_limit(0x01607D),Constant,Const=-600	Negative position limit
1	1-3	SetVariable	Var=Software_position_limit-Max_position_limit(0x02607D),Constant,Const=2400	Positive position limit
1	1-4	SetVariable	Var=Command_reference_source(0x002430),Constant,Const=1	Set Command Ref. Source to Analog input
0		MacroNumber	2	Set Source Mode back to normal
1	2-1	SetVariable	Var=Command_reference_source(0x002430),Constant,Const=0	Set Command Ref. Source to normal

First you need to select the input that you want to use (input 1 will work for hw versions 1.0 and 1.1), then set negative and positive position limit. This determines the position range which the analog input is scaled to fit. Then the reference source is switched to analog input.

**Practical hint:** If dynamics of the motion is not good, try to lower the profile acceleration and deceleration.

In order to go back to the normal method for creating a position profile you need to run the macro 2 in program sample shown above.

**Note:** The analog reference method requires continues analog-digital conversion. In the case of firmware 2 (12 bits instead of 10) this can result in poor operation if also a lot of communication over the serial port is going on (like being connected to the smac control center, doing real time data-logging).

## Output Program Examples

To write the analog output value (in counts) the object for the analog output can be used (0x12A04 in case of output 1 (LCC10), 0x22A04 for the output 2 (LCC11)). For firmware revision 2.0 and higher it is also possible to have a variable directly put on the output. Note that for activating the analog output the motor status must be on. The examples below show a partial program with placing variable W10 to the output.

### LCC10 Example

To create an analog output voltage of 5 V the following example can be used if using an LCC10.

#	Line	Command	Parameter
0		MacroNumber	4
1	4-1	SetVariable	Var=General_purpose_registers-W10(0x0A2C00),Constant,Const=1023
2	4-2	Motor	On
2	4-3	SetVariable	Var=Analog_output-Analog_output_1_value(0x012A04),Variable,Var1=General_purpose_registers-W10(0x0A2C00)

For an LCC10 the variable W10 (0x0A2C00) is first set with value 1023 (max value for 10 bit).

You must take care that the motor status is ON to enable the analog output.

In the next line the variable W10 written to analog output 1 value (0x012A04).

The voltage coming from the analog output will be 5.0V (equals value 1023).

### LCC11 Example

To create an analog output voltage of 10 V the following example can be used if using an LCC11.

#	Line	Command	Parameter
0		MacroNumber	4
1	4-1	SetVariable	Var=General_purpose_registers-W10(0x0A2C00),Constant,Const=65535
2	4-2	SetVariable	Var=Analog_output-Analog_output_2_value(0x022A04),Variable,Var1=General_purpose_registers-W10(0x0A2C00)

For an LCC11 the variable W10 (0x0A2C00) is first set with value 65535 (max value for 16 bit) .

In the next line the variable W10 is written to analog output 2 value (0x022A04).

The voltage coming from the analog output will be 10.0V (equals value 65535).

**Note:** It is not required that the motor status is ON.

For firmware version 1.0 the analog output can only be controlled this way.

## Analog Output Automatic

For firmware versions 2.0 and higher you can also use Analog Output Automatic.

A program example of Analog Output Automatic is shown below

**Note:** Motor On command is required for the LCC10, for the LCC11 it is not required.

#	Line	Command	Parameter
0		MacroNumber	4
2	4-1	Motor	On
1	4-2	SetVariable	Var=Analog_output_automatic-Mode_enabled(0x012A08),Constant,Const=1
1	4-3	SetVariable	Var=Analog_output_automatic-Source_register(0x022A08),Constant,Const=24676
1	4-4	SetVariable	Var=Analog_output_automatic-Destination_output(0x032A08),Constant,Const=1
1	4-5	SetVariable	Var=Analog_output_automatic-Max_represented_value(0x042A08),Constant,Const=10000

The variable “**Mode enabled**” is used to switch on (or off) the Analog Output Automatic mode.  
(value = 0 is disabled, value = 1 is enabled)

The variable “**Source register**” determines which variable will be used to determine the analog output value. Setting the source object requires a decimal value representing the object number. The most used object numbers (Hex codes) and its corresponding decimal values are shown in the list below.

So in order to use actual position (0x6064) you need to enter decimal value 24676.

Source Object name	Hex code	Dec value
Position actual value	0x6064	24676
Position demand value	0x6062	24674
Following error actual value	0x60F4	24820
Torque actual value	0x6077	24695
Torque demand	0x6074	24692
Velocity actual value	0x606C	24684
Analog input 1 value	0x12A03	76291
Analog input 2 value	0x22A03	141827

The variable “**Destination output**” refers to the output number you want to use. The value is 1 (for LCC10) or 2 (for LCC11)

The variable “**Max represented value**” is used to match the required source object range to the voltage range of the analog output. The value of the source object which needs to correspond with the maximum voltage must be entered as the max represented value.

**Example:** The source object is the actual position. The position that must represent the full voltage is 2000 counts. Then enter 2000 as the Max represented value.

Depending on the range of the source object you can have two situations:

- If the source object has a signed range, the analog output will be offset automatically to the middle of its range and will be scaled to a range from -Max represented value to +Max represented value. Therefore, a zero value of the source object will be represented by the middle of the output voltage range.
- If the source object has an unsigned range of valid values, the analog output will be scaled to a range from 0 to Max represented value. A zero value of the source object will be represented by 0 Volt.