12.4 AM055

12.4.1 General Information

The AM055 is a standard analog mixed module. The module is equipped with a potentiometer voltage. The potentiometer voltage is 2-fold and can be loaded parallel with 4 x 1 kΩ.

12.4.2 Order Data

Model Number	Short Description	Image
3AM055.6	2005 analog mixed module, 5 inputs, 0 to 10 V, 12-bit, 3 outputs, +/- 10 V, 12-bit, 1 potentiometer voltage +10 V, 2x. Order TB170 terminal blocks separately.	
3TB170.9	2005 terminal block, 20-pin, screw clamps	
3TB170.91	2005 terminal block, 20-pin, cage clamps	
3TB170:90-02	2005 terminal block, 20-pin, 20 pcs., screw clamps	
3TB170:91-02	2005 terminal block, 20-pin, 20 pcs., cage clamps	
Terminal blocks not included in the delivery (see "Accessories").		

Table 246: AM055 order data

12.4.3 Technical Data

Product ID	AM055
General information	
C-UL-US Listed	Yes
B&R ID Code	$97
Slot Main Rack Expansion Rack	 Yes Yes
Inputs Input Signal	5 0 -10 V

Table 247: AM055 technical data

Product ID	AM055
Outputs Output Signal	3 ±10 V
Potentiometer Voltage	+10 V
Electrical Isolation Channel - PLC Channel - Channel	 Yes No
Operating Modes Normal Operation Special Operating Mode 1 Special Operating Mode 2	 Cyclic measurement with optional averaging Direct software timing Software timing using a default time of 2000 - 65535 µs
Conversion Time for all Channels Normal and Special Operation Normal Operation with Active Averaging	 < 1 ms < 1.5 ms
Power Consumption 5 V 24 V Total	 Max. 1.5 W Max. 5.5 W, including potentiometer voltage Max. 7 W
Analog Inputs	
Input Signal Nominal Min./Max.	 0 to +10 V -20 to +20 V
Conversion Procedure	Successive approximation
Digital Converter Resolution	12-bit
Output Format	INT $0000 - $7FF8 (1 LSB = $0008 = 2.441 µA)
Non-Linearity	±1 LSB
Load	2 MΩ
Basic Accuracy at 25° C	±0.05% 1)
Offset Drift	Max. ±0.0025% /° C 1)
Gain Drift	Max. ±0.005% /° C 2)
Analog Outputs	
Output Signal	±10 V
Digital Converter Resolution	12-bit
Output Format	INT $8080 - $7F80 (1 LSB = $0010 = 4.90 mV)
Non-Linearity	±1 LSB
Load	Min. 1 kΩ
Basic Accuracy at 25° C Offset Total	 ±0.025% 1) ±0.1% 1)
Offset Drift	Max. ±0.0013% /° C 1)
Gain Drift	Max. ±0.003% /° C 2)
Switch On/Off Behavior	Internal enable relay during boot procedure or error: short circuit Short circuit

Table 247: AM055 technical data (cont.)

Product ID	AM055
Potentiometer Voltage	
Output Voltage	+10 V
Load	4 x 1 kΩ parallel, max total 40 mA
Short Circuit Current	> 100 mA
Basic Accuracy	0.02% 3)
Drift over Temperature Range	0.04% 3)
Mechanical Characteristics	
Dimensions	B&R 2005 single-width

Table 247: AM055 technical data (cont.)

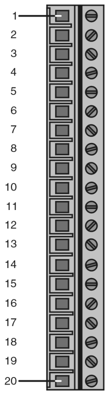
1) Refers to the measurement range.
2) Refers to the current measurement value.
3) Referring to 10 V.

12.4.4 Status LEDs

Image	LED	Description
	RUN	A lit RUN LED indicates the analog/digital converter and digital/analog converter are running.
	MODE	The MODE LED flashes briefly if a start pulse is detected in one of the two special operating modes.

Table 248: AM055 status LEDs

12.4.5 Pin Assignments



TB170

Connection	Assignment
1	Pot. Supply I1 + 2
2	AGND I1 + 2
3	+ Input 1
4	- Input 1
5	+ Input 2
6	- Input 2
7	Pot. Supply I3 + 4
8	AGND I3 + 4
9	+ Input 3
10	- Input 3
11	+ Input 4
12	- Input 4
13	+ Input 5
14	- Input 5
15	+ Output 1
16	- Output 1
17	+ Output 2
18	- Output 2
19	+ Output 3
20	- Output 3

Table 249: AM055 pin assignment

Signal Cable Connection

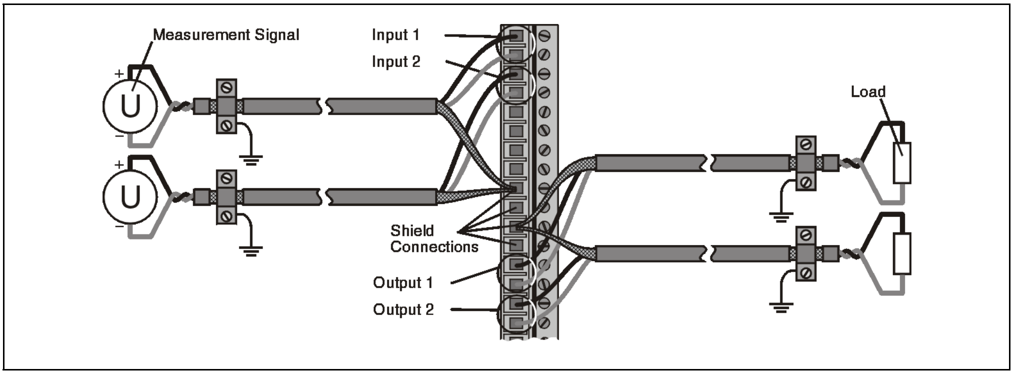


Figure 153: AM055 signal cable connection

Shielded cabling should be used for the mixed module's analog input and output signal cables. The cable shield must be grounded near the terminal block.

Due to EMC reasons, it is recommended to short circuit the inputs which are not used.

Potentiometer Operation

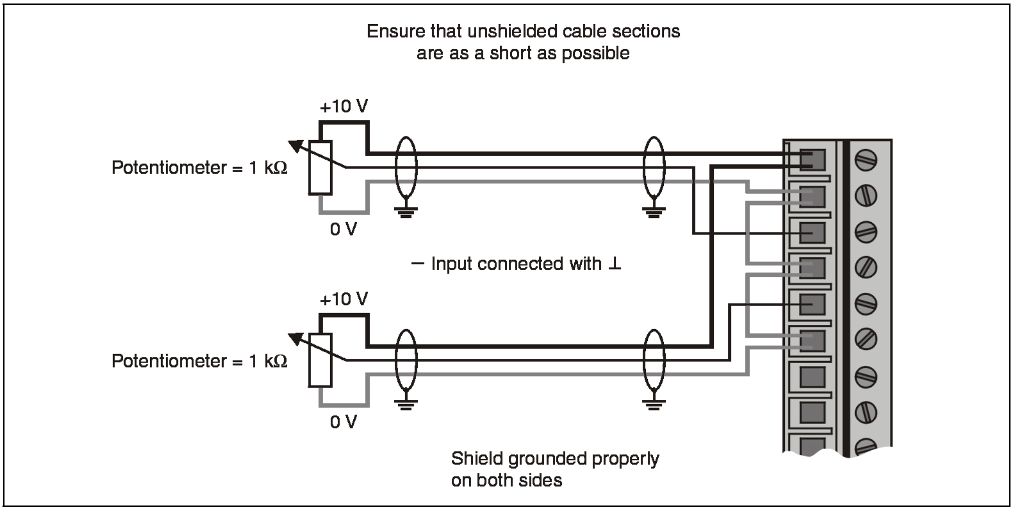


Figure 154: AM055 potentiometer operation

12.4.6 Input Circuit Diagram

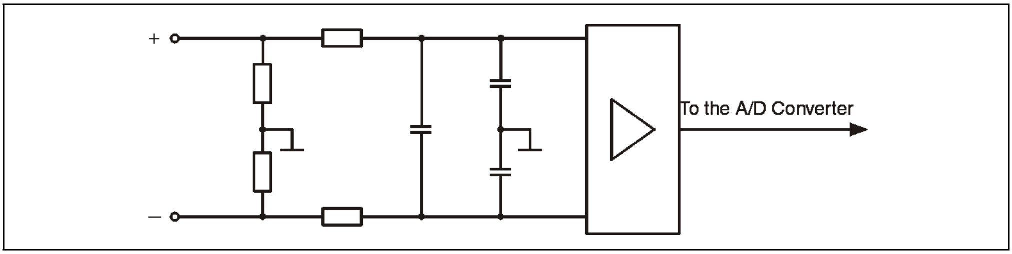


Figure 155: AM055 input circuit diagram

12.4.7 Output Circuit Diagram

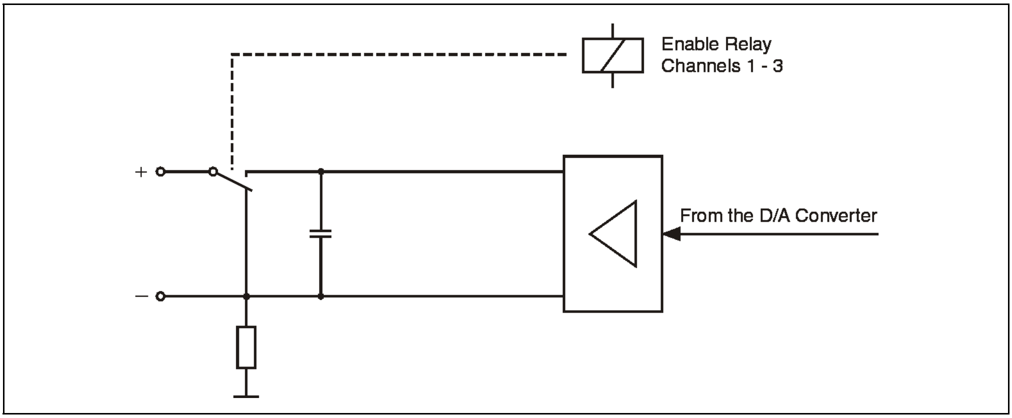


Figure 156: AM055 output circuit diagram

12.4.8 Operating Modes

Three operating modes are available:

- Normal operation (default setting)
- Special Operating Mode 1: Direct software timing
- Special Operating Mode 2: Software timing using default time

Change of Operating Mode

- Normal operation is set during power-on or after a reset. The enable relay releases the outputs approximately 300 ms after a reset.
- Changing from normal operation to one of the special operating modes is possible at any time. To do this, the mode register 2 must be set to the respective value. When a change in operating mode is carried out, it is acknowledged in status register 2, the register which displays the current operating mode.
- However changing from one of the special operating modes to another operating mode is not possible.

Normal Operation

Normal operation is set after a power-on.

<u>Analog Inputs</u>

All channels are converted cyclically and data is deposited in the dual ported RAM in the agreed INT format. The conversion time for all channels is <1 ms.

Averaging can only be switched on in cyclic operation, using mode register 1. The conversion time increases slightly to <1.5 ms due to the higher computing time needed.

<u>Analog Outputs</u>

All values are read and written on the analog output channels. The update time for the analog outputs should be considered in the above listed conversion times for the analog inputs.

Special Operating Mode 1: Direct software timing

Mode register 2 must be set to the following value: %00010000

In this operating mode, the conversion cycle is started on the module by the application program, which sets bit 7 from mode register 8 to 0 (start pulse).

All analog output values are then immediately read and written on the output channels. Finally, the conversion of all five input channels is carried out so that it does not react to another start pulse. The end of the cycles is registered by setting bit 7 in the status register 2.

Application Example: Data acquisition (without jitter) in high-speed-task classes (e.g. for a controller).

Mode Register 8	Analog Mixed Module	Time
Write access with bit 7 = 0 (start pulse)	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 -3	t_ao = t_0 + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Start measurement input channel 5	t_ao +5 * 85 µs
	Write measurements in the DPR (start up)	1)
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_0 + 900 µs
The next start pulse is possible	Module in delay loop	

Table 250: AM055 Special Operating Mode 1: Direct software timing

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

Special Operating Mode 2: Software timing using default time

Mode register 2 must be set to the following value: %00110000

The procedure is similar to special operating mode 1. However in special operating mode 2 there is the option to set the time when the next conversion cycle should be ended. The default time is entered in µs as UINT in mode register 7 + 8. This write access works in the same way as a start pulse (independent of bit 7 in the mode register 8). Further write accesses are ineffective until the end of the cycles.

The reading of analog output values and the conversion of all eight channels is not started immediately but rather 1000 µs before the end of the default time. The end of the cycles is registered by setting bit 7 in the status register 2. Unlike special operating mode 1, the time scale is left unchanged.

Value range for the default times: 2000 to 65535 µs

Application example: Equidistant data acquisition for controllers in normal task classes with the option of calculating the measurement time in the main CPU (e.g. using the timer function "TIM_musec" or "TIM_ticks" -> user program).

Example: Task 1 has a cycle time of 10 ms in task class 1 . At the end of the cycles, current analog values must be available for the next cycle.
The "TIM_musec" function measures the current time period. If the measurement results in 2 ms, then the analog conversion must be completed in 8 ms. Defining the default time carried out with the "IO_data" function. The value 8000 is written in mode registers 7 + 8.
If the time measured in the next cycle results in e.g. 2.2 ms, then the value 7800 must be written in mode registers 7 + 8 .

Mode Registers 7 + 8	Analog Mixed Module	Time
Default time written in µs as UINT	Module in delay loop	t_0
	Bit 7 in the status register 2 = 0	t_0 + 20 to 40 µs
	Delay Loop	Depends on t_pre
	Starting internal cycles	t_St = t_pre - 1000 µs
	Analog output values read from the DPR (start)	1)
	Analog output values read from the DPR (end)	1)
	Update analog outputs 1 -3	t_ao = t_St + 328.5 to 330 µs
	Start measurement input channel 1	t_ao + 1 * 85 µs
	Start measurement input channel 2	t_ao +2 * 85 µs
	Start measurement input channel 3	t_ao +3 * 85 µs
	Start measurement input channel 4	t_ao +4 * 85 µs
	Start measurement input channel 5	t_ao +5 * 85 µs
	Write measurements in the DPR (start up)	1)

Table 251: AM055 Special Operating Mode 2: Software timing using default time

Mode Registers 7 + 8	Analog Mixed Module	Time
	Write measurements in the DPR (end)	1)
	Bit 7 in the status register 2 = 1(cycle end)	t_pre - 100 µs
	Time entry sequence	t_pre
The next start pulse is possible	Module in delay loop	

Table 251: AM055 Special Operating Mode 2: Software timing using default time (cont.)

1) Bus accesses on the module can lead to interruptions in the reading of analog output values from the dual ported RAM (DPR) and/or the writing of the measurements in the dual ported RAM. Therefore, it is recommended that handling of affected I/O variables in the special operating modes should only be made by the "Direct_IO" FBKs.

12.4.9 Relationship between Converter Value and Input / Output Signals

Input Voltage 0 - 10 V

The converter value (INT format) changes in increments of 8 (0, 8, 16, etc.).

Input Voltage	Converter Value	
	Hexadecimal	Decimal
Error Status	$8000	-32768
≤0 A	$0000	0
2.441 mV	$0008	8
9.997 V	$7FF0	32752
≥10 V	$7FF8	32760

Table 252: AM055 Relationship between input voltage and converter value

Output Voltage ±10 V

The converter value (INT format) changes in increments of 16 (..., -32, -16, 0, 16, 32, etc.).

Converter Value		Output Voltage
Hexadecimal	Decimal	
≤$8080	-32640	-10 V
$FFF0	-16	-4.901 mV
$0000	0	0 V
$0010	16	4.901 mV
≥$7F80	32640	10 V

Table 253: AM055 Relationship between output voltage and converter value

12.4.10 Variable Declarations

The variable declaration is made in B&R Automation Studio™:

Function	Variable Declarations				
	Scope	Data Type	Length	Module Type	Chan .
Single Analog Input (Channel x)	tc_global	INT	1	Analog In	1 ... 5
Single analog output (channel x)	tc_global	INT	1	Analog Out	1 ... 3
Mode Register 1	tc_global	USINT	1	Status Out	0
Mode Register 2	tc_global	USINT	1	Status Out	1
Mode Registers 7 + 8 Special Operating Mode 2 "Software Timing using Default Values"	tc_global	UINT	1	Status Out	6
Mode Register 8 Start pulse in the special operating mode 1 "Direct Software Timing"	tc_global	USINT	1	Status Out	7
Status Register 1	tc_global	USINT	1	Status In	0
Status Register 2	tc_global	USINT	1	Status In	1

Table 254: AM055 variable declaration

Mode Register 1

Bits 0 and 2 - 7 must be assigned with 0.

Mode Register 1	Bit	Description
	7	0
	6	0
	5	0
	4	0
	3	0
	2	0
	1	AV - Averaging switched on
	0	0

0	0	0	0	0	0		0
7							0

Averaging

Averaging can be activated during normal operation. It should be noted that the conversion time increases to <1.5 ms.

AV= 0 .... Averaging switched off (default setting)
AV = 1 ...... Averaging switched on

When this option is switched on, the average value is generated and transferred to the central unit. The calculation is formulated as follows:

$$\text{New Average Value} = \frac{\text{Old Average Value} + \text{New Value}}{2}$$

The positive limit for averaging is $7FF7 instead $7FF8.

Mode Register 2

Bits 0 - 3 as well as 6 and 7 must be assigned with 0.

Mode Register 2	Bit	Description
	7	0
	6	0
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	0
	2	0
	1	0
	0	0

0	0			0	0	0	0
7							0

SWT_DIR 0 ...... Normal operation (default setting)
1 ...... Special operating mode 1 (Direct Software Timing)

SWT_TIM SWT_TIM is only active if SWT_DIR is set to 1!
0 ...... Operating mode dependent on SWT_DIR (default setting)
1 ...... Special operating mode 2 (software timing using default times)

Changing from one of the special operating modes to another operating mode is not possible!

Mode Register 7 + 8 (UINT)

When using special operating mode 2 "Software Timing using Default Times", the time is defined in µs in both of these registers. The conversion cycle of all analog inputs and analog outputs must be completed when this time has passed.

Value range: 2000 to 65535 µs

Mode Register 8

Bits 0 - 6 must be assigned with 0.

Mode Register 8	Bit	Description
	7	TRIGn - Start pulse
	6	0
	5	0
	4	0
	3	0
	2	0
	1	0
	0	0

	0	0	0	0	0	0	0

7 0

TRIGn	TRIGn is only active in "Direct Software Timing" operating mode (SWT_DIR to 1, SWT_TIM to 0) A write access with TRIGn = 0 triggers a conversion cycle. A write access with TRIGn = 1 is ignored.

Status Register 1

Status Register 1	Bit	Description
	7	x
	6	x
	5	x
	4	x
	3	x
	2	x
	1	AV - Averaging switched on
	0	I_ERR - Module error

x	x	x	x	x	x		

7 0

I_ERR 0...... Data values in the dual ported RAM (DPR) correspond to definitions
1...... An internal error exists. Please contact B&R.

MW Averaging in normal operation is active (mode register 1 settings are repeated)

Status Register 2

Status Register 2	Bit	Description
	7	SWT_RDY - Software timed measurement is completed
	6	x
	5	SWT_TIM - Software timing using default time
	4	SWT_DIR - Direct software timing
	3	x
	2	x
	1	x
	0	x

	x			x	x	x	x

7 0

SWT_DIR
SWT_TIM SWT_DIR and SWT_TIM indicate the operating mode in which in the module can be found.

SWT_RDY SWT_RDY is only active if a special operating mode is set.
0......Measurement or waiting loop is running
1......The last cycle is completed