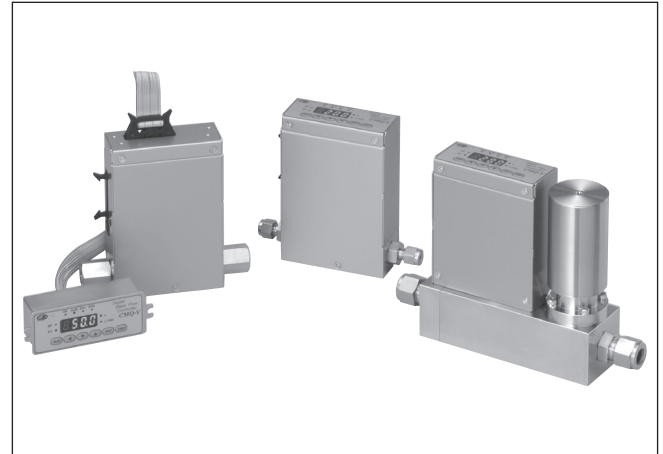


Digital Mass Flow Controller for Hydrogen and Helium Gases

Overview

The MQV is a digital mass flow controller that incorporates a thermal microflow sensor developed by Azbil Corporation and a proportional solenoid valve, and achieves high performance by utilizing advanced actuator control technology.

To meet the need for high speed and wide-range mass flow controllability, this high-performance, low-price, next-generation controller is designed for general industrial use.



Features

- Advanced 300 ms high-speed control
The ultra-high-speed response microflow sensor and unique digital PID tuning realize exceptionally high-speed response in reaching the set flow rate from a fully closed state.
The MQV also responds quickly to changes in the primary pressure, minimizing the effect on the flow rate on the secondary side.
- The power circuit is isolated from analog I/O circuits. If the analog I/Os of multiple MQV controllers are connected by a PLC or the like, there is no need to use an isolated circuit in the analog module on the PLC side. Also, a shared power supply can be used for the MQV.
- A standard specification MQV controller can operate at a low differential pressure of 50 kPa or even less.
The controller is the only unit of its kind that can handle low-pressure control applications such as burner air-fuel ratio control.
- The MQV offers a best-of-class wide control range of 1 to 100 % FS.
- Either an integrated display model or a separate display model can be selected according to the application needs.
- MQV controllers can be used over a wide operating temperature range (-10 to +60 °C).
- There is no need to use an expensive, dedicated dual power supply because the controller can be powered using a single readily available general-purpose 24 V DC power supply. An AC adapter is also available, making the MQV perfect for use in a laboratory setting or similar application.

Specification

Item	MQV9020	MQV9050	MQV9500	MQV0005	MQV0010	MQV0050	MQV0200
Valve type	Proportional solenoid valve						
Valve operation	Normally closed (N.C.) when no power is supplied						
Standard full scale flow rate *1	20.0 mL/min (standard)	50.0 mL/min (standard)	0.500 L/min (standard)	5.00 L/min (standard)	10.00 L/min (standard)	50.0 L/min (standard)	200 L/min (standard)
Gas type	Hydrogen (H ₂), helium (He) The gas must be dry and not contain corrosive components (chlorine, sulfur, acid, etc.). Also, it must be clean, without dust or oil mist.						
Control	Control range	1 to 100 % FS (see Table 1 on page 4)					
	Valve output update cycle	5 ms					
	Responsiveness (at standard differential pressure)	0.5 s max. (typ.) to the setting ± 2 % FS		0.3 s max. (typ.) to the setting ± 2 % FS			
		(when control begins with valve fully closed, or during control when any setting is changed)					
	Accuracy (at the standard temperature and standard differential pressure; Q: flow rate)	(1) ± 1 % FS (50 % FS < Q \leq 100 % FS) (2) ± 0.5 % FS (0 % FS < Q \leq 50 % FS)	± 1 % FS	(1) ± 2.0 % FS (80 % FS < Q \leq 100 % FS) (2) ± 1.0 % FS (40 % FS < Q \leq 80 % FS) (3) ± 0.5 % FS (0 % FS \leq Q \leq 40 % FS)			
	Repeatability (Q: flow rate)	(1) ± 0.5 % FS (50 % FS < Q \leq 100 % FS) (2) ± 0.25 % FS (0 % FS < Q \leq 50 % FS)	± 0.5 % FS	(1) ± 0.5 % FS (40 % FS < Q \leq 100 % FS) (2) ± 0.25 % FS (0 % FS \leq Q \leq 40 % FS)			
	Effect of temperature (for hydrogen)	0.06 % FS max. per 1 °C					
Effect of pressure (for hydrogen)	0.2 % FS max. per 100 kPa						
Pressure	Standard differential pressure	100 kPa (inlet pressure: 100 kPa [gauge]; outlet pressure: 0 kPa [gauge])		200 kPa (inlet pressure: 200 kPa [gauge]; outlet pressure: 0 kPa [gauge])			
	Minimum differential pressure *2	(1) Hydrogen: 2.5 kPa (2) Helium: 5 kPa	(1) Hydrogen: 10 kPa (2) Helium: 20 kPa	(1) Hydrogen: 20 kPa (2) Helium: 40 kPa	(1) Hydrogen: 80 kPa (2) Helium: 150 kPa	(1) Hydrogen: 20 kPa (2) Helium: 40 kPa	(1) Hydrogen: 100 kPa (2) Helium: 180 kPa
	Operating differential pressure range (T: operating temperature)	300 kPa max. (-10 °C \leq T \leq 60 °C)					
	Allowable inlet pressure	0.5 MPa *3					
	Pressure resistance (allowable inlet pressure)	1 MPa (gauge)					
	Temperature	Standard operating temperature	+ 23 °C				
	Allowable operating temperature	-10 to +60 °C					
	Allowable storage temperature	-20 to +70 °C					
Humidity	Allowable operating humidity	10 to 90 % RH (without condensation)					
External leakage	Helium leakage rate	1 \times 10 ⁻⁶ Pa·m ³ /s max.					
Flow rate setting	Setting method	(1) Use of the keys, (2) External analog input, (3) Loader communication, *4 (4) RS-485 communication (3-wire system) *5					
	Setting resolution	See Table 1 on page 4.					
	External analog input	Input range: 0–5 V / 1–5 V DC / 0–20 mA / 4–20 mA (switchable) Input impedance: 1 M Ω \pm 10 % for voltage input, 250 Ω \pm 10 % for current input					
Flow rate display	Display method	4-digit 7-segment LED display					
	Display resolution	See Table 1 on page 4.					
	Indication accuracy (at the standard temperature and standard differential pressure; Q: flow rate)	(1) ± 1 % FS \pm 1 digit (50 % FS < Q \leq 100 % FS) (2) ± 0.5 % FS \pm 1 digit (0 % FS \leq Q \leq 50 % FS)	± 1 % FS \pm 1 digit	(1) ± 2 % FS \pm 1 digit (80 % FS < Q \leq 100 % FS) (2) ± 1 % FS \pm 1 digit (40 % FS < Q \leq 80 % FS) (3) ± 0.5 % FS \pm 1 digit (0 % FS \leq Q \leq 40 % FS)			

	Item	MQV9020	MQV9050	MQV9500	MQV0005	MQV0010	MQV0050	MQV0200
Totalizing function	Display range	0 to 99,999,999 mL		0.00 to 999,999.99 L	0.0 to 9,999,999.9 L	0 to 99,999,999 L	0 to 99,999,999 L	0.01 to 999,999.99 m ³
	Display resolution	1 mL		0.01 L	0.1 L	1 L	1 L	0.01 m ³
	Totalizer count backup cycle	(1) Every 200 ml (2) 1 hour after the previous backup, (3) Whenever the RUN key is pressed	(1) Every 500 ml	(1) Every 5 L	(1) Every 50 L	(1) Every 100 L	(1) Every 500 L	(1) Every 2 m ³
Analog output	Output type	Instantaneous flow rate (PV) output or set flow rate (SP) output (switchable)						
	Output scale	0 to full-scale flow rate (scale can be changed)						
	Output range	0–5 V / 1–5 V DC / 0–20 mA / 4–20 mA (switchable)						
	Maximum output	7 V DC max. / 28 mA max. (max. output when flow rate exceeds the range)						
	Accuracy	±0.3 % FS (overall output accuracy: indication accuracy ±0.3 % FS)						
	External load resistance	250 kΩ min. for voltage output, 300 Ω max. for current output						
Alarm/event output	Number of outputs	1 alarm output, 2 event outputs						
	Output rating	30 V DC, 30 mA max. (open collector non-isolated output)						
	Totalizer pulse output width	100 ms ±10 % (when totalizer pulse output is selected)						
	Totalizer pulse output rate	1 mL/pulse	0.01 L/pulse	0.1 L/pulse	1 L/pulse	1 L/pulse	0.01 m ³ /pulse	
External switching input	Input type, number of inputs	1 external 3-way switching input, 3 external contact inputs (2-way switching)						
	Required circuit type	Non-voltage contacts or open collector						
	Terminal voltage with contacts OFF	2.5 ±0.5 V for external 3-way switching input, 2.8 ±0.5 V for external contact input						
	Terminal current with contacts ON	Approx. 0.5 mA (current to contacts)						
	Allowable ON contact resistance	250 Ω max.						
	Allowable OFF contact resistance	100 kΩ min.						
	Allowable ON residual voltage	1.0 V max. (with open collector)						
	Allowable OFF leakage current	50 μA max. (with open collector)						
Reference voltage output	Output rating	5.0 V DC ±5 %, 5 mA max.						
	Application	Reference voltage for setting the flow rate and for 5 V external 3-way switching input						
Communication	Method	(1) Loader communication *4 (2) RS-485 communication (3-wire system) *5						
	Transmission speed	2400, 4800, 9600, 19200, 38400 bps (only 19200 bps for loader communication)						
Power	Rated power	24 V DC, current consumption 300 mA max.						
	Allowable supply voltage (T: operating temperature)	21.6 to 26.4 V DC (ripple: 5 % max.) (-10 °C ≤ T ≤ 60 °C)						
	Isolation	The power circuit and I/O circuits are isolated.						
Gas-contacting material	SUS316, Teflon, fluoroelastomer							
Connection method	1/4 Swagelok, 1/4 VCR			9/16 - 18 UNF, Rc 1/4, 1/4 Swagelok, 1/4 VCR				
Mounting orientation	Horizontal, but not with the display facing down							
Weight	Approx. 1.2 kg							
Applicable standards	EN 61326-2-3:2013, EN 61326-1:2013 (to be used in an industrial electromagnetic environment) During EMC testing, the reading or output may fluctuate by the equivalent of ±10 % FS.							

*1 L/min (standard) indicates the volumetric flow rate per minute (L/min) converted to conditions of 20 °C and 101.325 kPa (1 atm). The standard temperature can be changed to 0, 25, or 35 °C. The controllable flow rate range varies depending on the gas type. See Table 1 on page 4.

*2 Minimum required differential pressure for control of full-scale flow rate (condition: outlet pressure = 0 kPa [gauge]). Operation is possible at less than the minimum differential pressure, but the controllable flow rate range narrows. See the graphs on page 5 for the relationship between differential pressure and flow rate when the valve is open fully.

*3 For the advisability of using an inlet pressure greater than 0.5 MPa (gauge), contact the azbil Group.

*4 Requires a dedicated loader package (MLP100A100), which is sold separately.

*5 This function is available only for models with the RS-485 communications function.

Functions

Function	Description
Flow totalization	A maximum of eight digits can be used for the amount of total flow (to 99,999,999). (For display resolutions, see the specification table.)
Alarm indicator / DO / valve shutoff	An upper/lower limit flow rate alarm for deviation of the instantaneous flow rate from the set flow rate, and a valve drive current alarm can be set. The valve can be forcibly opened or closed when an alarm occurs.
OK indicator	Lit and event is on when flow rate is within set value \pm allowable range.
Event indicator / DO	<ul style="list-style-type: none"> · Total flow event output · Totalizer pulse output · OK output · Output mode output Two of the above event outputs can be selected.
Automatic shutoff	The valve can be shut off automatically under the following conditions: <ul style="list-style-type: none"> · When the total flow count reaches the preset value. · When one of the alarms, including flow rate alarms, is triggered. Note: The valve of this device cannot completely shut off the flow. If complete shutoff is required, install a separate shutoff valve.
Automatic reset of total flow count	The total flow count can be automatically reset when control begins. Setup is either by the keys or by external switch input.
Forced opening/closing of valve	The valve can be fully opened or closed by the keys or external switch input.
Multiple SP setup	One of eight (max.) preset flow rate values can be selected by the keys or external switch input.
Direct SP change	The SP can be changed simply by pressing the \blacktriangle and \blacktriangledown keys.
Full multi-range setting	The control range can be set within 10 to 100 % of the standard range in increments of 1 % FS. The control range can be changed freely according to the application. Additionally, two preset control ranges can be switched by external switch input. This function can also be used to change the resolution setting.
Slow start	This function prevents a sudden change in the controlled flow rate when control begins or when the set point is changed.
Gas type switching	The operating gas can be selected from the standard gases by the keys. Additionally, two preset gases can be switched by external switch input.
Gas type conversion	Special gases or mixed gases can be controlled by specifying the conversion factor (CF).
SP ramp	Two SP change rates (gradients) can be specified at the start of control operation or when changing the settings. Also, an external switch can be connected to the device to change the rate.
Valve drive current alarm	This function monitors the proportional valve drive current and outputs an alarm under certain conditions. Note: Depending on the differential pressure and other factors, the valve drive current may fluctuate even if the set flow rate is the same.
Loader communications	A communications port for loader communications is included as a standard feature. The dedicated loader package (MLP100A100), which is sold separately, enables one-to-one communication with a PC. (Various settings can be changed and the process can be monitored on the PC.)
RS-485 communication (option)	3-wire RS-485 communication is available as an option (transmission speed: 2400 to 38400 bps)

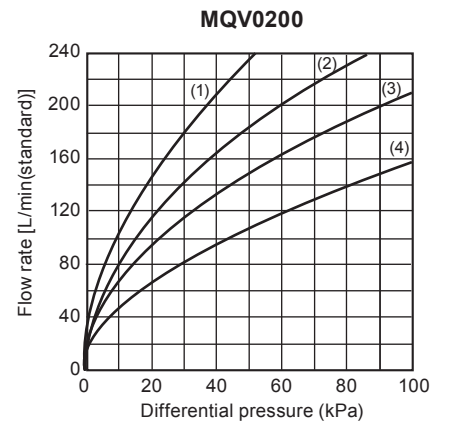
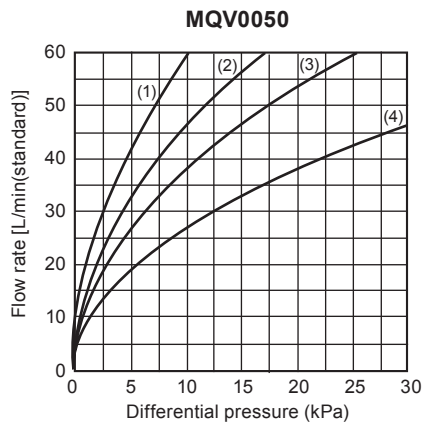
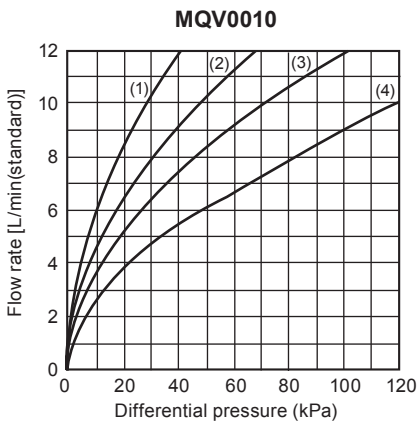
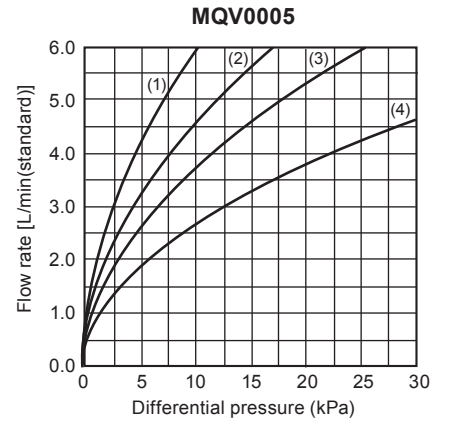
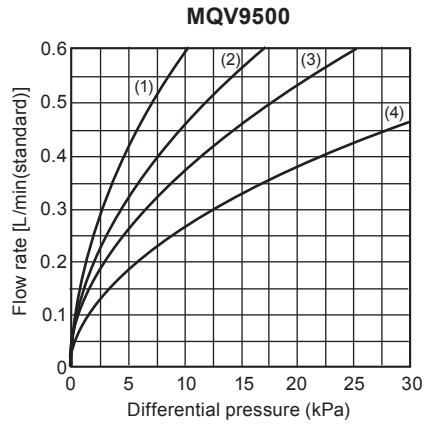
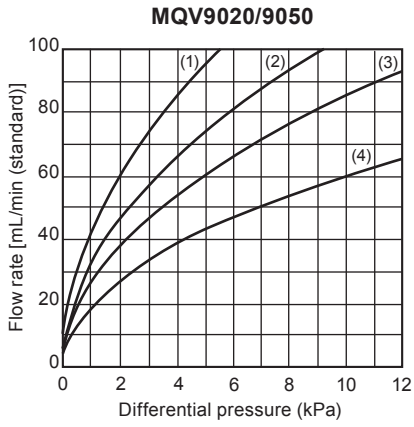
Table 1. Controlled flow rate range and setting/display resolution

Gas type	MQV9020		MQV9050		MQV9500		MQV0005	
	Flow rate control range mL/min (standard)	Setting/display resolution mL/min (standard)	Flow rate control range mL/min (standard)	Setting/display resolution mL/min (standard)	Flow rate control range L/min (standard)	Setting and display resolution L/min (standard)	Flow rate control range L/min (standard)	Setting/display resolution L/min (standard)
Hydrogen	0.2 to 20.0	0.1	0.4 to 50.0	0.2	0.004 to 0.500	0.002	0.04 to 5.00	0.02
Helium	0.2 to 20.0	0.1	0.4 to 50.0	0.2	0.004 to 0.500	0.002	0.04 to 5.00	0.02

Gas type	MQV0010		MQV0050		MQV0200	
	Flow rate control range L/min (standard)	Setting/display resolution L/min (standard)	Flow rate control range L/min (standard)	Setting/display resolution L/min (standard)	Flow rate control range L/min (standard)	Setting/display resolution L/min (standard)
Hydrogen	0.10 to 10.00	0.05	0.4 to 50.0	0.2	2 to 200	1
Helium	0.10 to 10.00	0.05	0.4 to 50.0	0.2	2 to 200	1

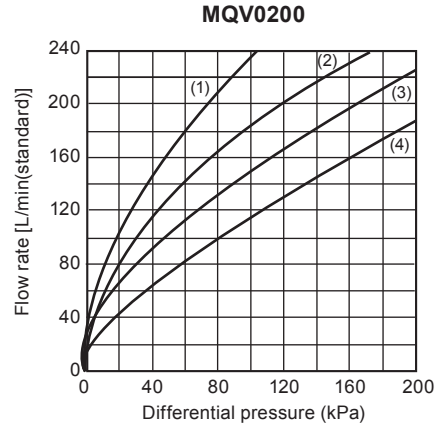
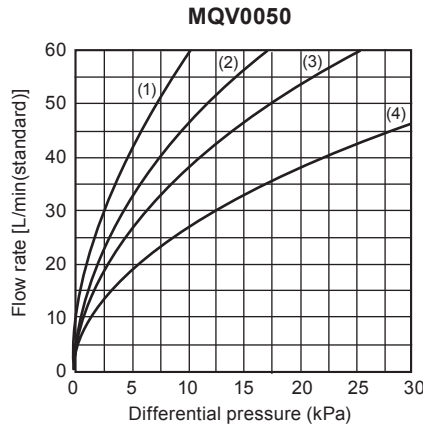
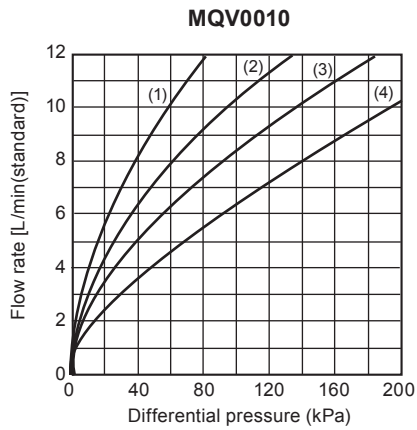
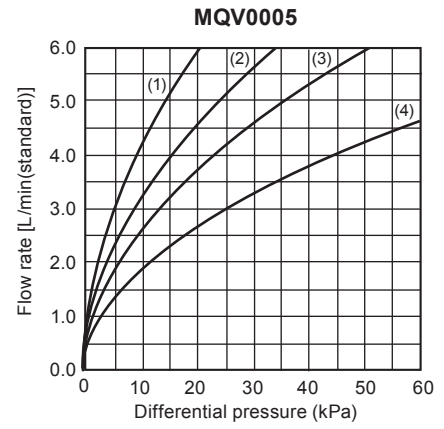
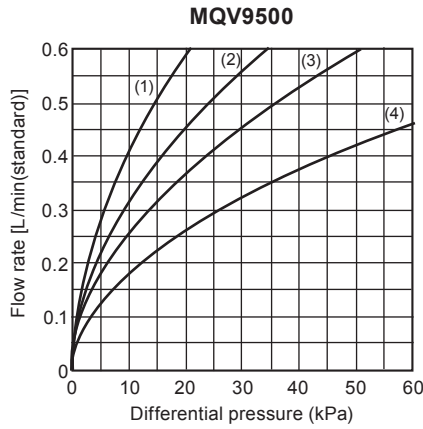
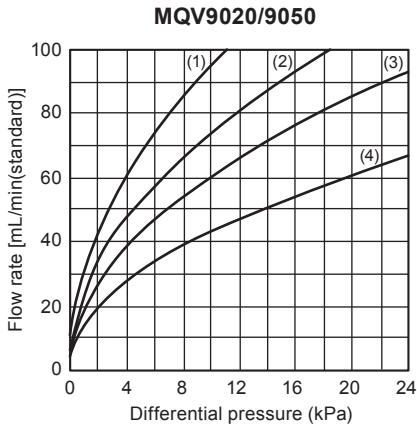
· If settings are input and flow rate is output by analog signals, setting/display resolution will be much higher. Please contact the azbil Group.

Relationship between differential pressure and flow rate when the valve is open fully (for hydrogen)



Outlet pressure
 (1) 150kPa (gauge)
 (2) 50kPa (gauge)
 (3) 0kPa (gauge)
 (4) -50kPa (gauge)

Relationship between differential pressure and flow rate when the valve is open fully (for helium)



Outlet pressure
 (1) 150kPa (gauge)
 (2) 50kPa (gauge)
 (3) 0kPa (gauge)
 (4) -50kPa (gauge)

! Handling Precautions

- For an output pressure not shown on the graphs above, calculate the flow rate with one of the formulas below.

(1) When $P2/P1 > 0.53$,

$$Q = C1 \sqrt{(P1 - P2)P2}$$

(2) When $P2/P1 \leq 0.53$,

$$Q = C2 \cdot P1$$

P1: Inlet absolute pressure [kPa(abs)]

P2: Outlet absolute pressure[kPa (abs)] (= gauge pressure + 101.3kPa)

Q: Flow rate [L/min (standard)](but for MQV9020/9050: [mL/min(standard)])

C1, C2: Constants (differing according to the model)

For hydrogen

MQV9020: C1= 2.684, C2=1.340

MQV9050: C1= 2.684, C2=1.340

MQV9500: C1= 0.01181, C2=0.00590

MQV0005: C1= 0.1181, C2=0.0590

MQV0010: C1= 0.1181, C2=0.0590

MQV0050: C1= 1.181, C2=0.590

MQV0200: C1= 2.091, C2=1.044

For helium

MQV9020: C1= 1.904, C2=0.950

MQV9050: C1= 1.904, C2=0.950

MQV9500: C1= 0.00838, C2=0.00418

MQV0005: C1= 0.0838, C2=0.0418

MQV0010: C1= 0.0838, C2=0.0418

MQV0050: C1= 0.838, C2=0.418

MQV0200: C1= 1.483, C2=0.740

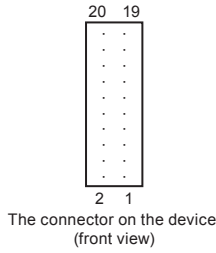
Example: If hydrogen is introduced into the MQV0200 with an inlet pressure of 100 kPa (gauge) and an outlet pressure of 80 kPa (gauge), the calculation will be:

$$P1=201.3\text{kPa(abs)}, P2=181.3\text{kPa(abs)} \rightarrow P2/P1=0.901$$

$$Q = 2.091 \times \sqrt{(201.3-181.3) \times 181.3} \\ = 126 \text{ [L/min(standard)]}$$

Terminal Connections

Connector pin layout



Connector model No.: HIF3BA-20PA-2.54DS (made by Hirose Electric Co.)

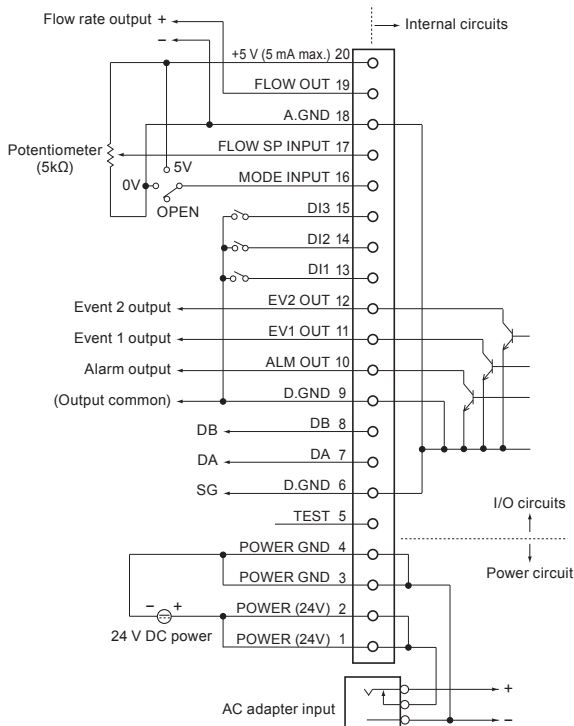
Compatible connectors

Connector type	Connector model No.	Contact model No.	Compatible wire
Crimp type	HIF3BA-20D-2.54C	HIF3-2226SCC	#22–26 AWG (separate wires can be used)
Pressure-weld type	HIF3BA-20D-2.54R	Not needed	#28 AWG (flat cable only)

Connector pin names

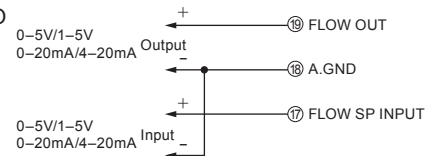
Pin No.	Signal name	Description	Notes
20	+ 5 V (5 mA max.)	5 V DC reference voltage output	5 mA max.
19	FLOW OUT	Instantaneous flow rate (PV) voltage output or flow rate set point (SP) output	0–5 V, 1–5 V, 0–20 mA, or 4–20 mA
18	A.GND	Analog ground	Common ground for analog signals
17	FLOW SP INPUT	Preset instantaneous flow rate (SP) voltage input	0–5 V, 1–5 V, 0–20 mA, or 4–20 mA input
16	MODE INPUT	External 3-way switching	3-stage switching input (OPEN / GND / 5 V)
15	DI3	External contact input 3	2-stage switching input (OPEN/GND)
14	DI2	External contact input 2	
13	DI1	External contact input 1	
12	EV2 OUT	Event output 2	Open collector non-isolated output
11	EV1 OUT	Event output 1	
10	ALM OUT	Alarm output	
9	D.GND	Digital ground	Common ground for digital signals
8	DB	RS-485 DB	Used for communication models only.
7	DA	RS-485 DA	
6	D.GND	Digital ground	Common ground for digital signals
5	TEST	For testing purposes	For tests. Do not use.
4	POWER GND	Power ground	Connect two wires in parallel to the power supply in order to reduce voltage drop caused by wiring resistance.
3	POWER GND	Power ground	
2	POWER (24 V)	Power + (24 V DC)	
1	POWER (24 V)	Power + (24 V DC)	

Wiring example

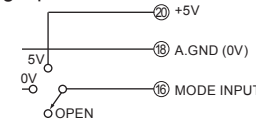


- Do not input any signal to pin No. 5.
- The power circuit is isolated from the input/output circuit inside this device.
- Even though the analog GND and digital GND are connected internally, be sure to ground them separately.
- When the AC adapter plug is inserted, the power supply is automatically switched to the AC adapter.
- The old model of AC adapter (No. 81446682-001, 15 V DC, 350 mA) cannot be used with this device.

*1. Analog I/O



*2. External 3-way switching input



Handling Precautions

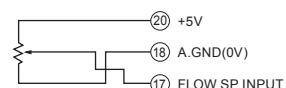
- When switching by relay contacts, use an appropriate relay intended for microcurrent use (with gold contacts). Failure to do so may cause faulty contact, resulting in malfunction.

Operation of external 3-way switching input

Input state of pin No.16		OPEN	0 V	5 V
Assigned function	Operating mode switching #1	Control	Fully closed	Fully open
	SP No. switching	SP-0	SP-1	SP-2
Switching of totalizing operation		Resume counting	Reset	Stop counting
Analog input/output I/O voltage range switching	Input	Internal reference 0–5 V* / external reference 0–20 mA	External reference 0–5 V / 0–20 mA	External reference 1–5 V / 4–20 mA
	Output	0–5 V / 0–20 mA	0–5 V / 0–20 mA	1–5 V / 4–20 mA
Operating mode switching #2		Fully closed	Control	Fully open

* The internal reference voltage applies when the 5 V DC reference voltage output pin (No. 20) on this device is used to configure settings through an externally connected potentiometer.

*3. Analog input (0–5 V) when using a potentiometer



Model selection

• Low-flow models

Basic model No.	Standard flow rate range	Type	Flow path material	Con-nection method	Gas type	Additional function					Suffix	Description	
						1	2	3	4	5			
MQV												Digital mass flow controller	
	9020											0.2–20.0 mL/min (standard) *1	
	9050											0.4–50.0 mL/min (standard) *1	
	9500											0.004–0.500 L/min (standard) *1	
	0005											0.04–5.00 L/min (standard) *1	
	0010											0.10–10.00 L/min (standard) *1	
	0050											0.4–50.0 L/min (standard) *1	
	0200											2–200 L/min (standard) *1	
			B										Integrated display (flow path length: 90 mm)
			C										Separate display (flow path length: 90 mm)
				S									SUS316
					R								Rc 1/4 (cannot be selected for MQV9020 or MQV9050)
					S								1/4 Swagelok
					V								1/4 VCR
					U								9/16 -18 UNF (cannot be selected for MQV9020 or MQV9050)
						H							Hydrogen *2
							0						No optional functions
								0					No optional functions
									1				RS-485 (CPL) communications
										0			No optional functions
											1		Degreasing for gas-contacting parts
											0	No optional functions	
											D	With inspection report	
											Y	With traceability certification	
											0	Product version	

*1 mL/min (standard) and L/min (standard) indicate the volumetric flow rate per minute (mL/min, L/min) converted to conditions of 20 °C and 101.325 kPa (1 atm). The standard temperature can be changed to 0, 25, or 35 °C.

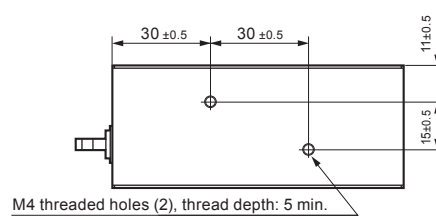
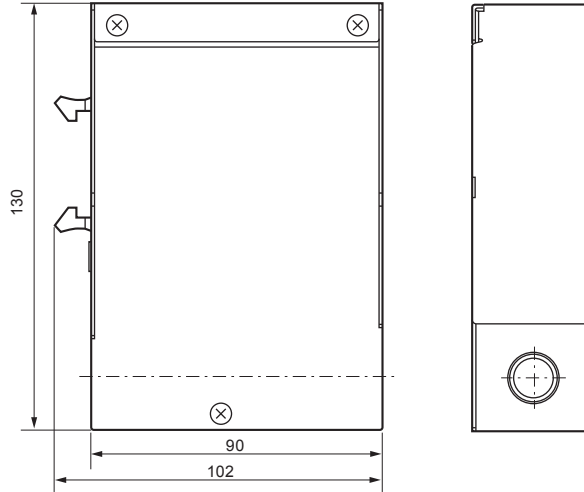
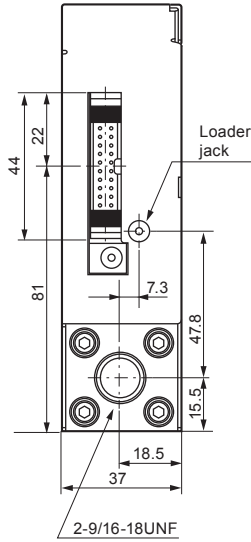
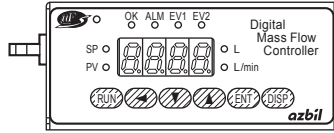
*2 The factory setting is hydrogen. The device can be used for helium gas by changing the gas type setting.

External Dimensions

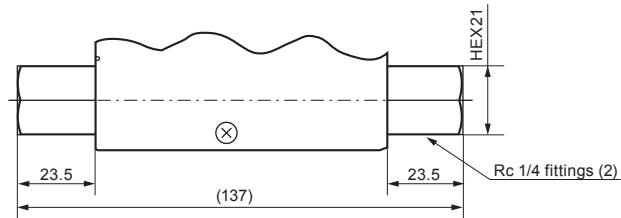
- **Models with integrated display**

- For low-flow models (MQV9020 and MQV9050), only 1/4 Swagelok and 1/4 VCR connections apply.

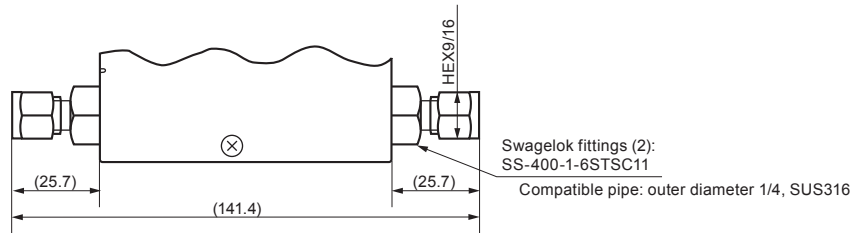
(Unit: mm)



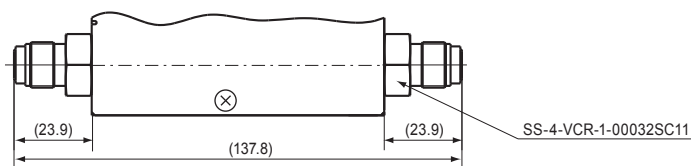
9/16 - 18 UNF connection type



Rc 1/4 connection type



1/4 Swagelok connection type

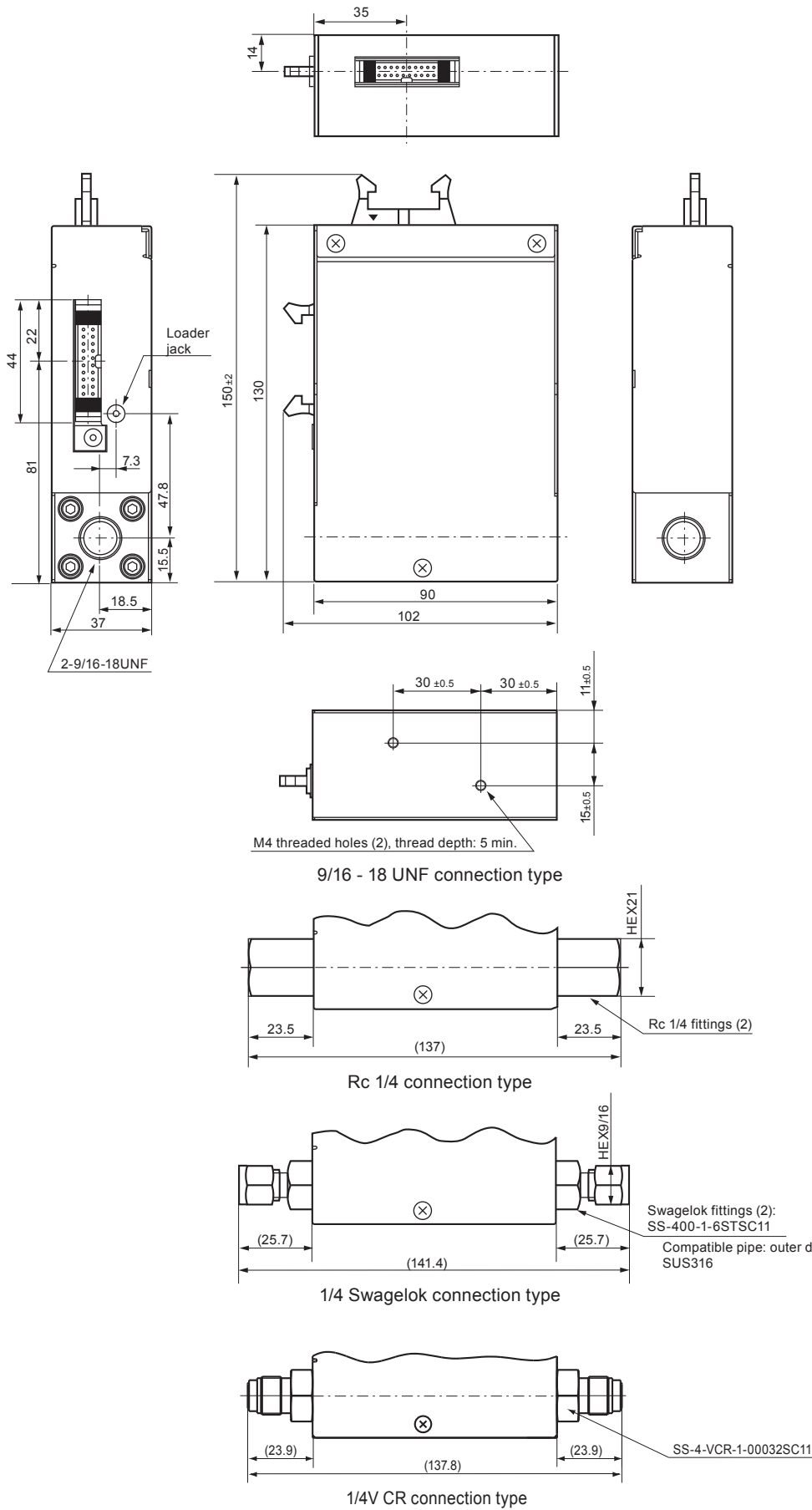


1/4 VCR connection type

• **Models with separate display (main unit)**

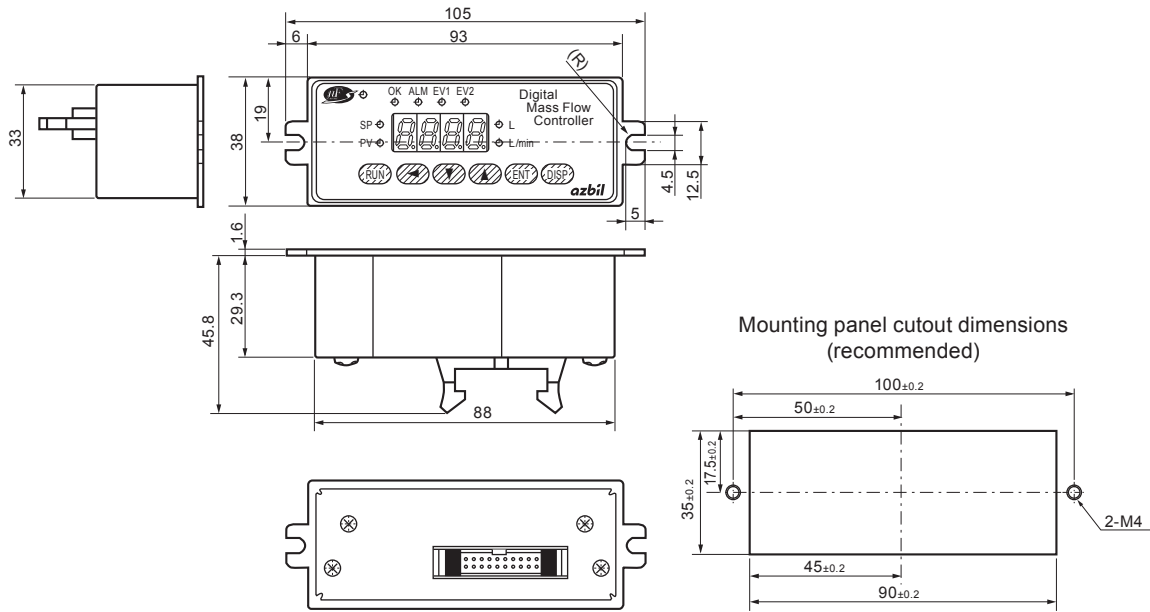
- For low-flow models (MQV9020 and MQV9050), only 1/4 Swagelok and 1/4 VCR connections apply.

(Unit: mm)



- Models with separate display (display)

(Unit: mm)



- Cable for connecting display to the main unit

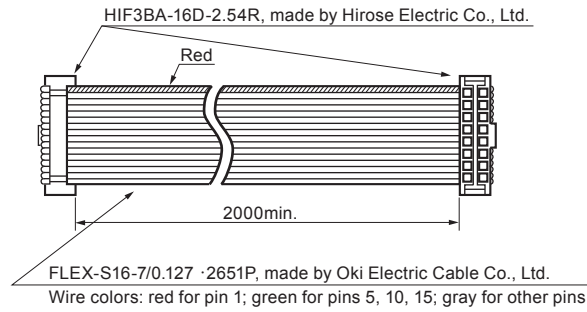
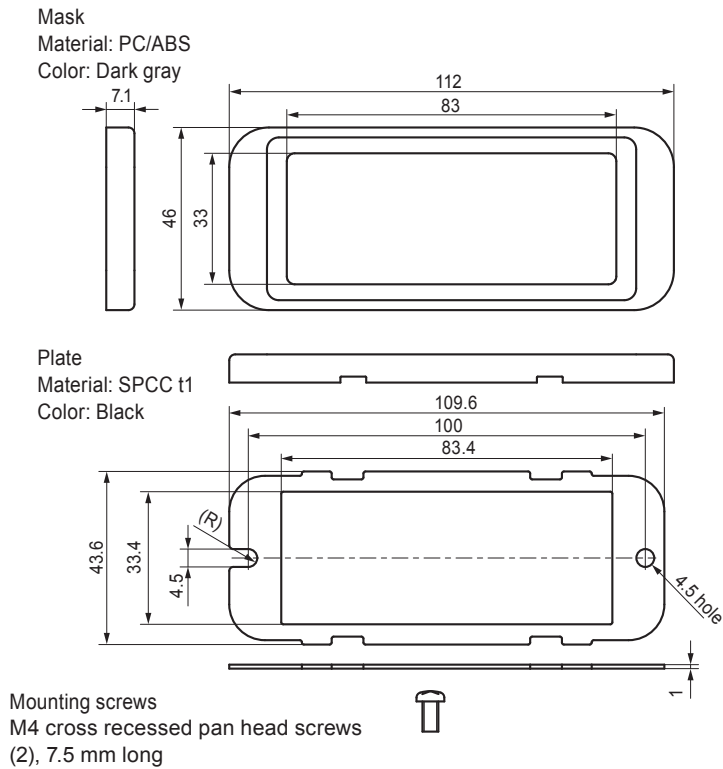


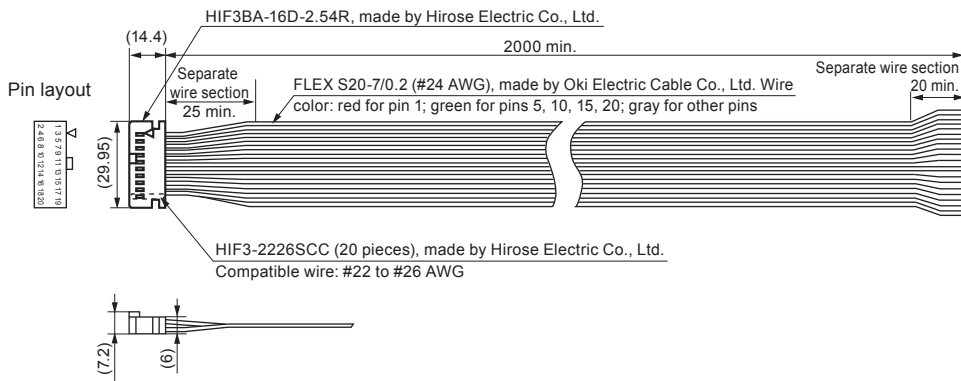
Table 2. Optional parts (sold separately)

Product name	Model No.	Description
Cable with dedicated connector	81446681-001	20-wire flat cable, 2 m (#24 AWG)
	81446951-001	20-wire shielded cable, 5 m
AC adapter	81446957-001	Rated voltage Input: 100 to 240 V AC Output: 24 V DC / 750 mA Operating temperature range: 0 to 40 °C
Potentiometer for flow rate setting	81446683-002	5 kΩ with digital dial, 10 turns
Cover for separate display unit	81446858-001	Mask (1): PC/ABS, dark gray Plate (1): SPCC t1, black Mounting screws (2): 7.5 mm M4 cross recessed pan head screws

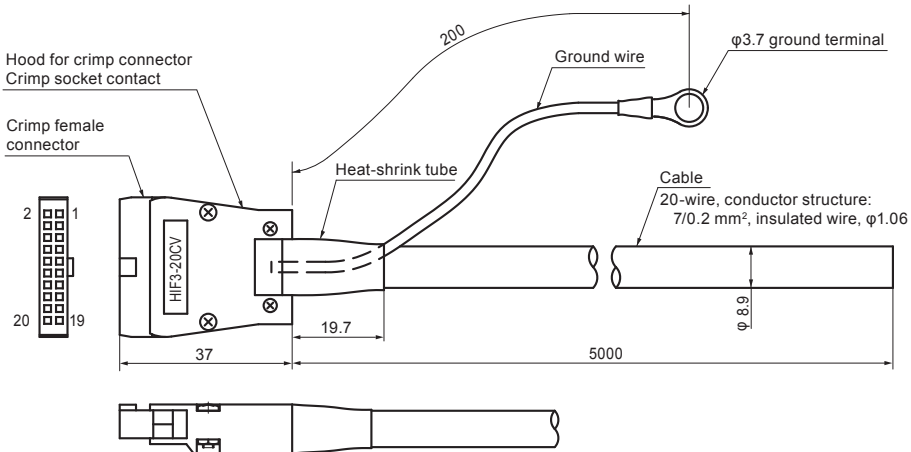
- Cover for separate display (model No. 81446858-001)



- Cable with dedicated connector
- 20-wire flat cable (model No. 81446681-001)

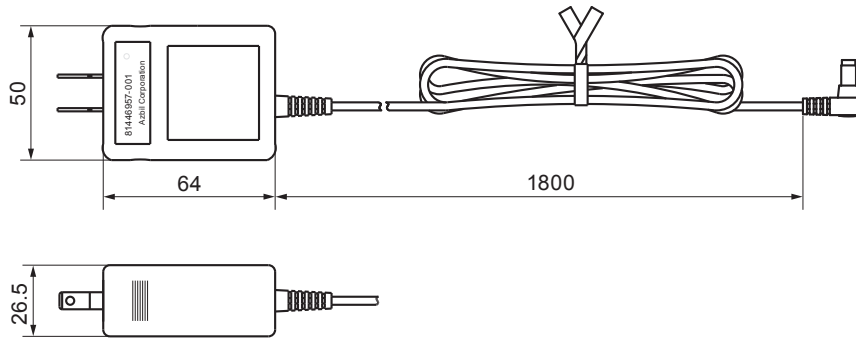


- 20-wire shielded cable (model No. 81446951-001)



Pin No.	Lead wire color
1	Black
2	Black & white
3	Red
4	Red & white
5	Green
6	Green & white
7	Yellow
8	Yellow & white
9	Brown
10	Brown & white
11	Blue
12	Blue & white
13	Gray
14	Gray & white
15	Orange
16	Orange & white
17	Purple
18	Purple & white
19	Light green
20	Light green & white

- AC adapter (model No. 81446957-001)



Please read "Terms and Conditions" from the following URL
before ordering and use.
<http://www.azbil.com/products/factory/order.html>

Specifications are subject to change without notice.

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