Synchro-feed Welding System

Next Generation Model of Ultra Low Spatter Welding System

NEW

Synchro-feed Evolution

Almega Friendly series II

Features of Synchro-feed Evolution

Synchro-feed has been made easier to use and more powerful.

1. Synchro-Feed Welding Process
2. New Control: Push-Arc Process
3. New Control: Synchro-Feed Pulse
4. Simple Connection and Easy Maintenance
5. Two Types of Synchro-Feed

Welding Site Issues

Removing spatter
Reducing man-hours

Wasted man-hours for removing spatter

↓

Hindrances to productivity improvement

↓

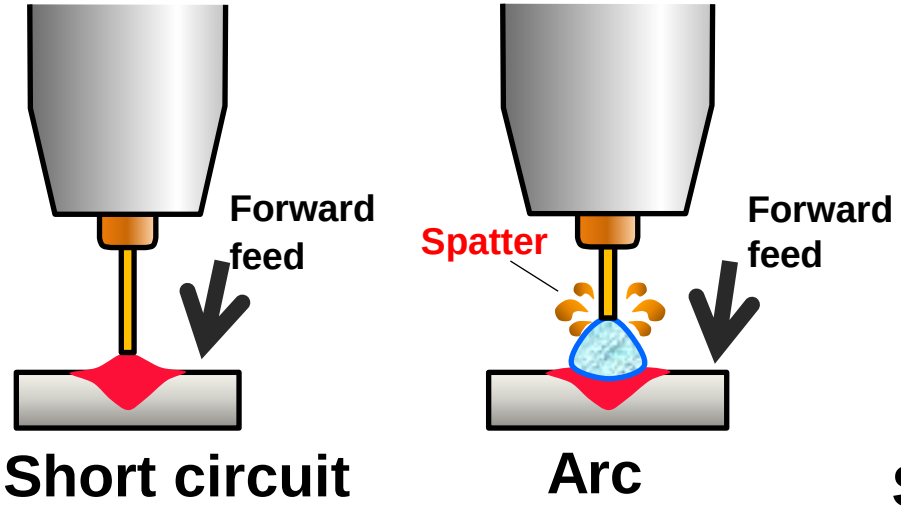
There is a limit to how much spatter can be reduced in the conventional low spatter welding process.

↓

Difficult to adapt to high-speed welding and thick plate welding

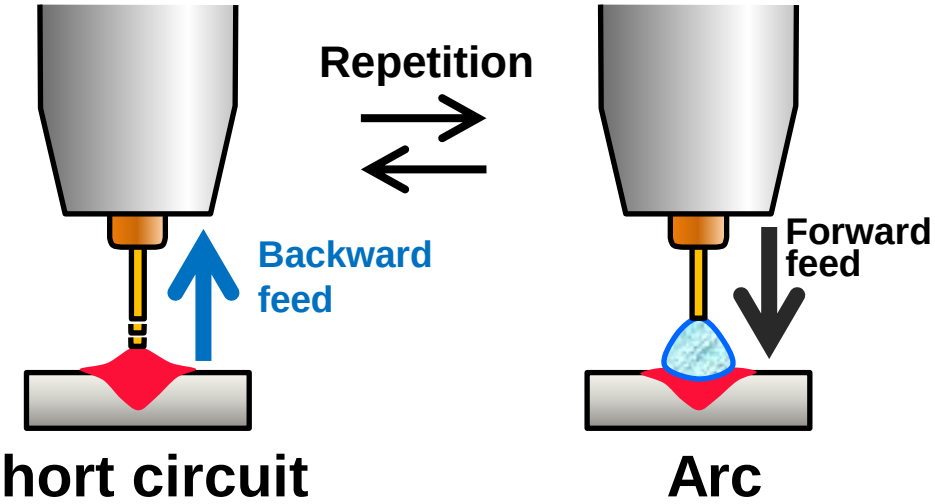
Synchro-Feed Welding Process

Conventional welding process



Wire is always fed forward

Synchro-feed welding process



Repeated forward and backward feed of wires

\+ In addition,

Daihen's original current waveform control

Achievement of high quality welding

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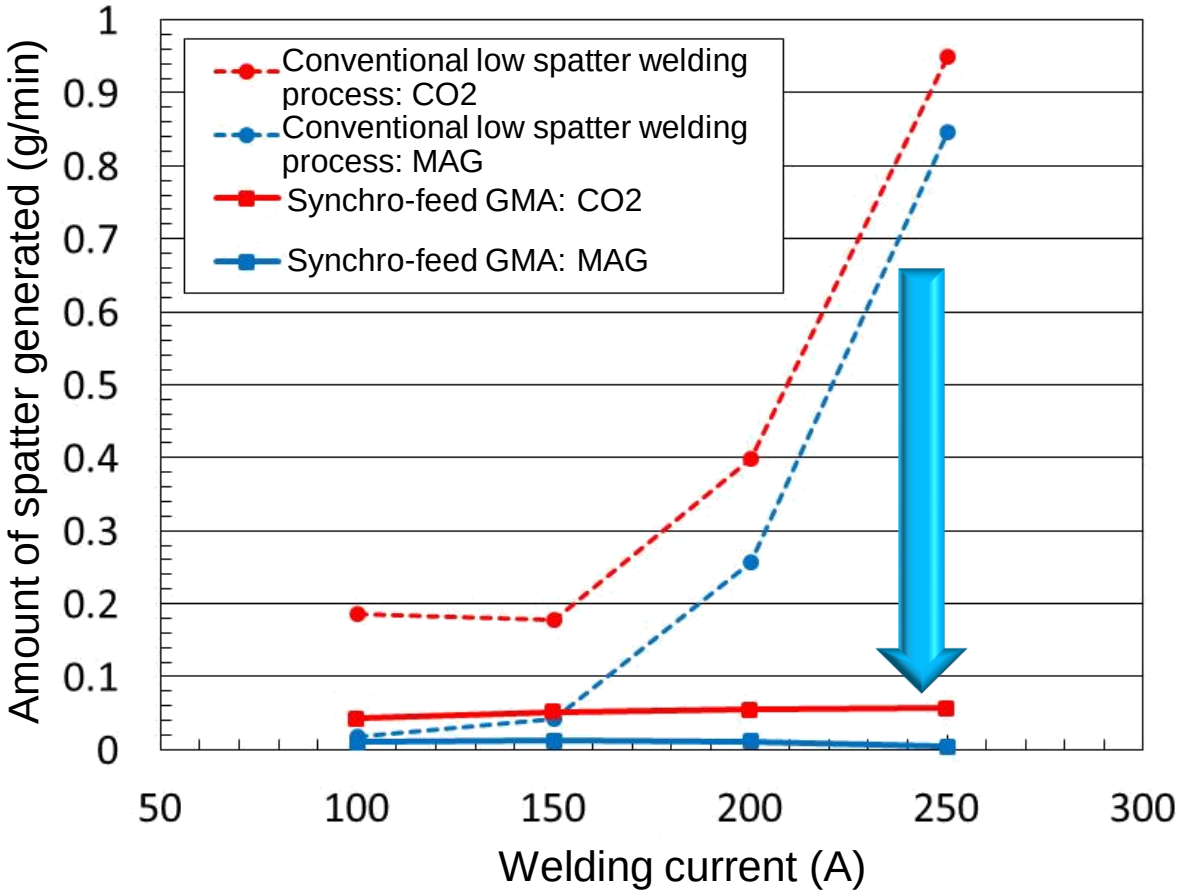
Ultra Low Spatter

Maximum 99 % spatter reduction



Spatter is significantly reduced in all current ranges!

Less than 1/10th of spatter was generated compared to the conventional welding process!

Synchro-feed significantly reduces spatter

Reduces the amount of spatter generated to 0.1 g/min or less in all areas

Ultra Low Spatter Welding

Comparison of the amount of spatter generated

Conventional welding process

Synchro-feed

<Conditions>
Average wire feed rate: 12 m/min
Short circuit and arc cycle: 100 Hz
Average current: 280 A
Welding speed: 100 cm/min
Shielding gas: CO2

Synchro-feed
Significantly
reduces spatter

Developing the Push-Arc Process

2014 1st Generation

Synchro-feed release

- Higher welding speed at higher duty cycle is required
- Lower spatter in stainless steel as well

2016 2nd Generation

Duty cycle 300 A, 100%
Stainless steel is supported

- Lower spatter in aluminum as well
- Brazing as well

2017 3rd Generation

Aluminum welding is supported
Brazing is supported

- Lower spatter in high speed welding as well
- Ensures penetration even into medium and thick plates
- Beautiful scale-like beads in aluminum

2019 4th Generation

Duty cycle 400 A, 100%
Synchro pulse is supported

2021 5th Generation

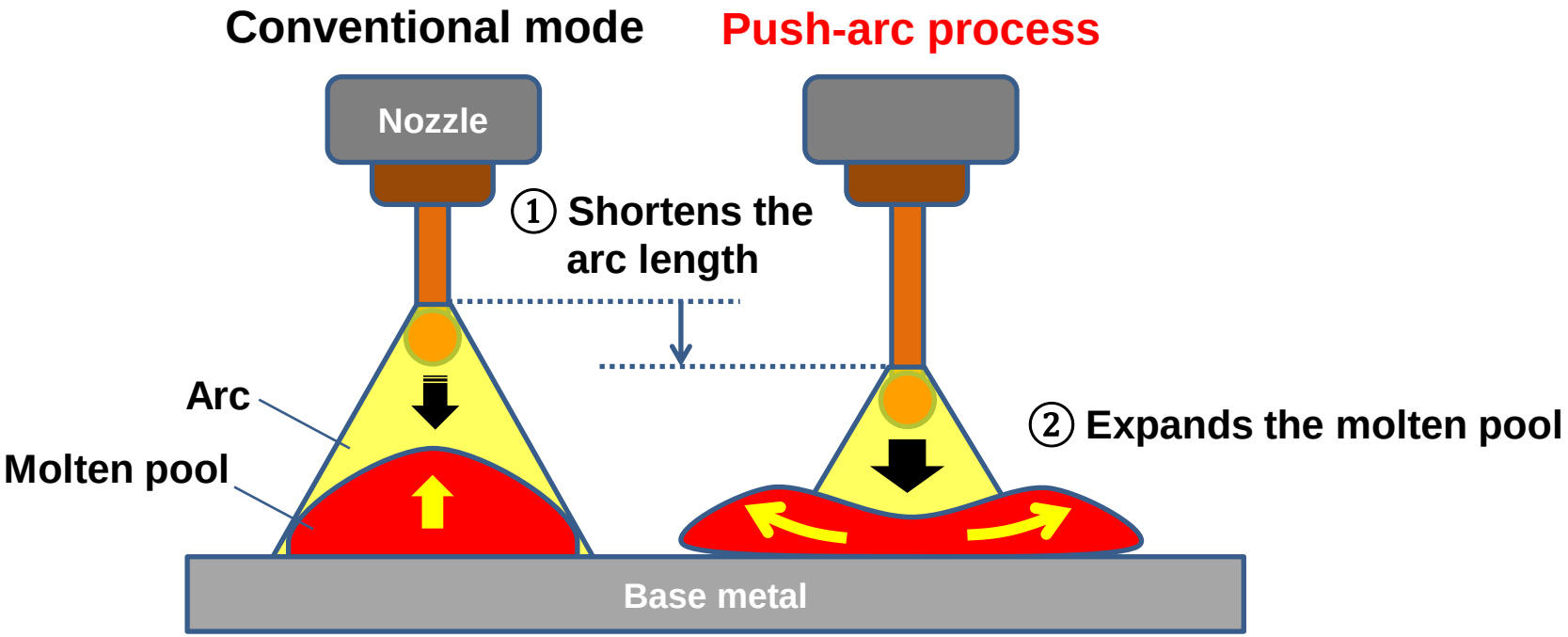
Flat beads
Simultaneous welding with multiple welders

- For when welding thin plates with flat beads is required
- Spatter increases when multiple welders are used to weld simultaneously. Lower spatter is required even if welded simultaneously using multiple welders.

Principles of the Push-Arc Process

What is push-arc process?

The Welding mode improves the wire feed frequency over conventional Synchro-feed welding and improves tolerance of joint resistance by placing wide and flat beads while maintaining conventional low spatter performance through application of new waveform control.

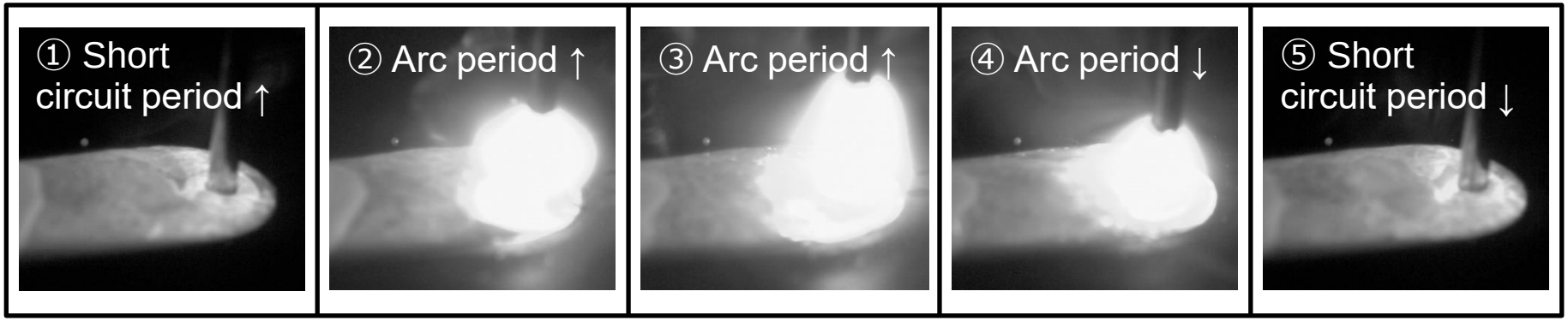


■ **Points**

"Wide weld beads are formed due to the '① short arc length' and by ② expanding the molten pool"

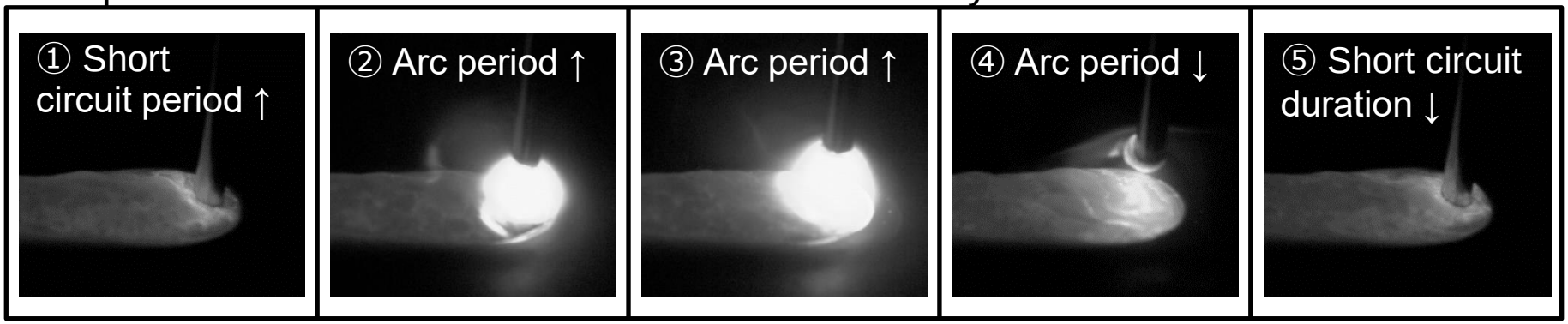
Principles of the Push-Arc Process

Droplet transfer in CO2 Synchro-feed push-arc process



The above photos ① to ③ show backward feed of wire while ④ and ⑤ show forward feed of wire. ① The wire is fed backward from the state of short circuit. ② An arc is generated. The wire is fed backward with the arc output to the state of ③. ④ A switchover to the state of feeding wire forward causes beads to expand by continuing the arc period during this time. The wire is short-circuited in ⑤ and then back to ① to repeat the short circuit and arc.

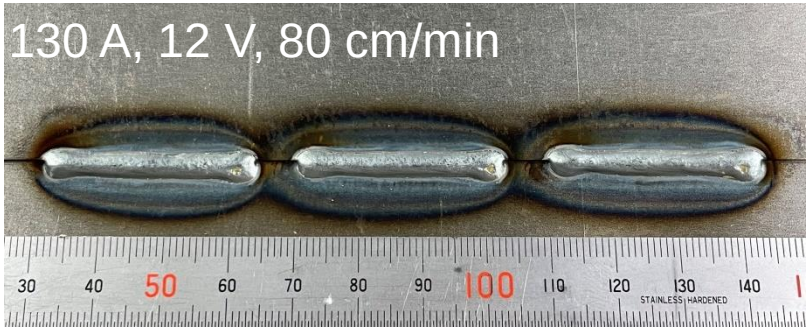
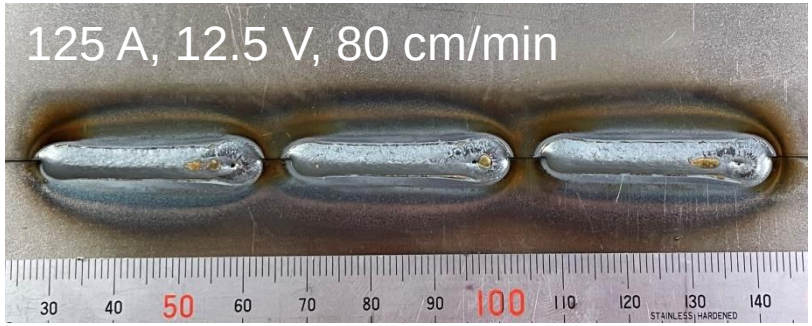
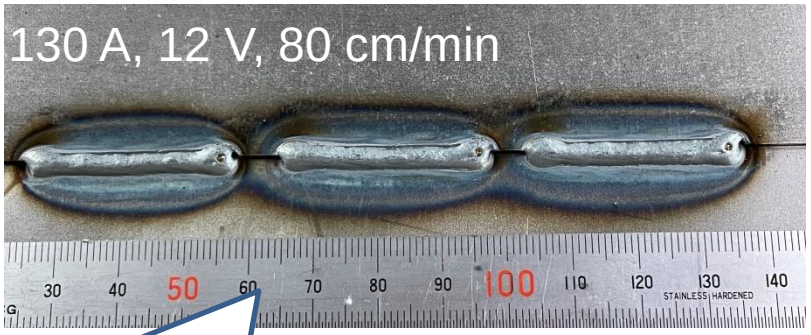
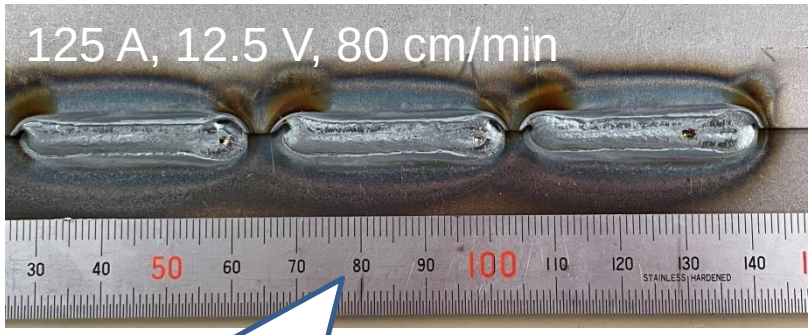
Droplet transfer in the conventional mode of CO2 Synchro-feed



The above photos ① to ③ show the backward feed of wire while ④ and ⑤ show forward feed of wire. ① The wire is fed backward from the state of short circuit. ② An arc is generated. The wire is fed backward to the state of ③, ④ the current value is kept low when the wire is fed forward, and the wire is short-circuited as in ⑤, and then back to ① to repeat the short circuit and arc.

Welding Sample (Mild Steel, MAG Welding)

Lap joint welding of 0.8 mm thick plate (wire diameter φ1.2)

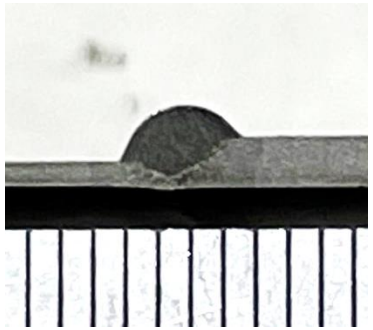
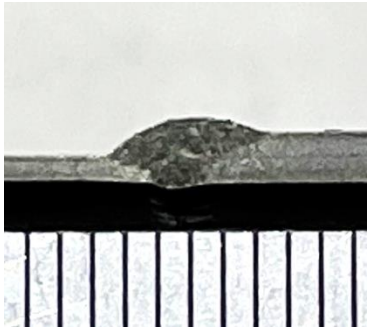
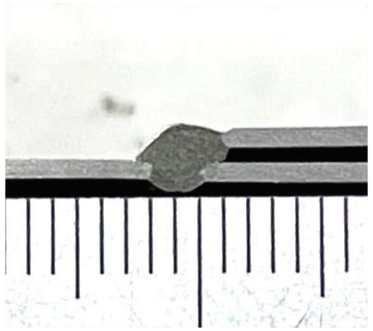
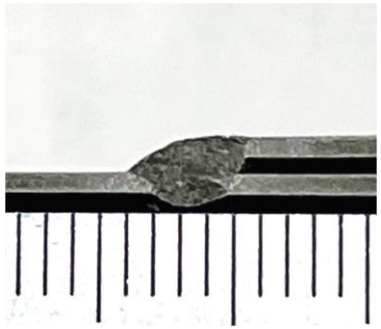
Gap	Conventional Synchro-feed	Push-arc process
0 mm		
0.8 mm		

Thin bead and undercutting tends to occur

Wide beads have been achieved

Welding Sample (Mild Steel, MAG Welding)

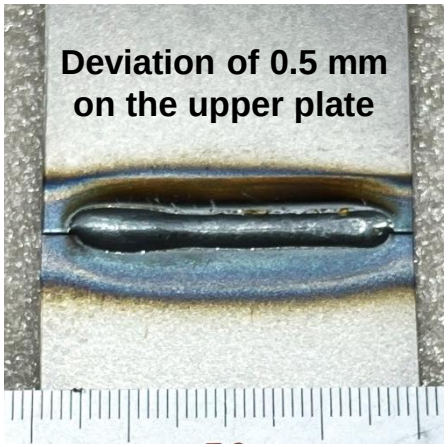
Lap joint welding of 0.8 mm thick plate (wire diameter φ1.2)

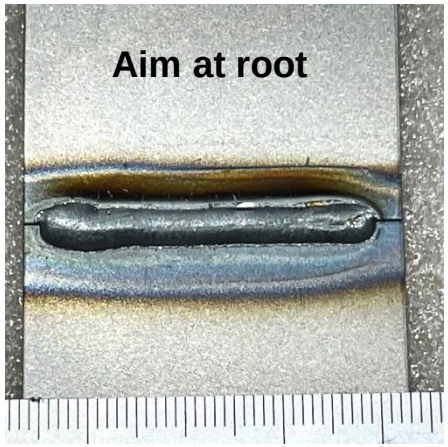
Gap	Conventional Synchro-feed	Push-arc process
0 mm	 Emboss bead	 Flat and wide bead
0.8 mm	 Thin bead and undercutting tends to occur.	 Flat and wide bead

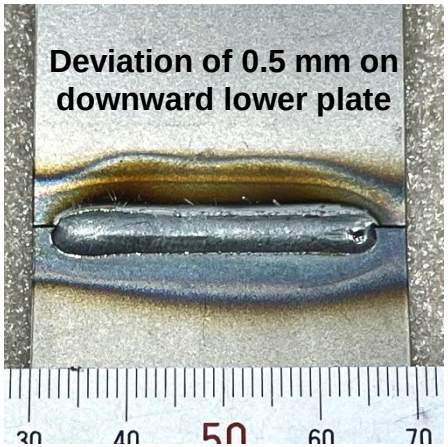
Welding Sample (Mild Steel, MAG Welding)

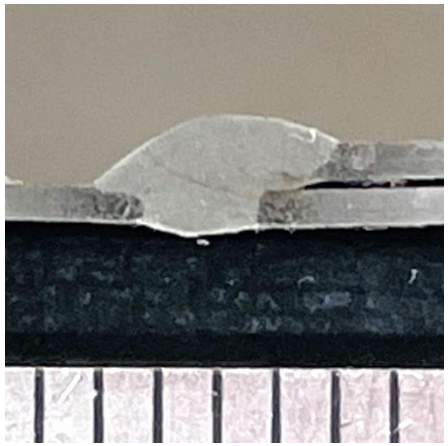
Plate thickness 0.6 mm, gap 0.3 mm tolerance to deviation aim

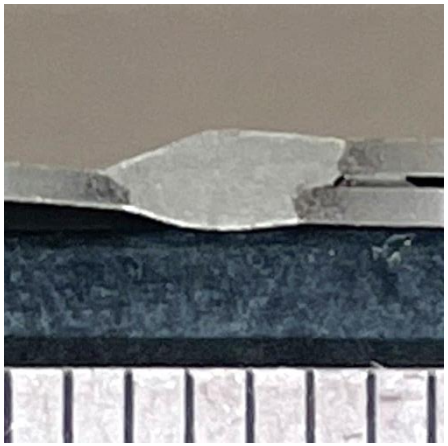
Current 70 A, voltage 14 V, welding speed: 70 cm/min, MAG gas, wire diameter 1.0 mmφ





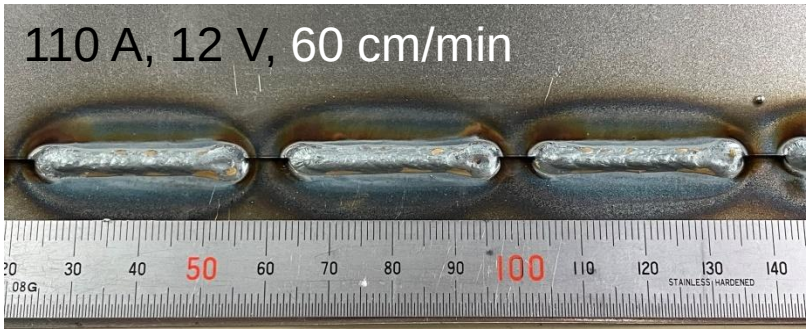
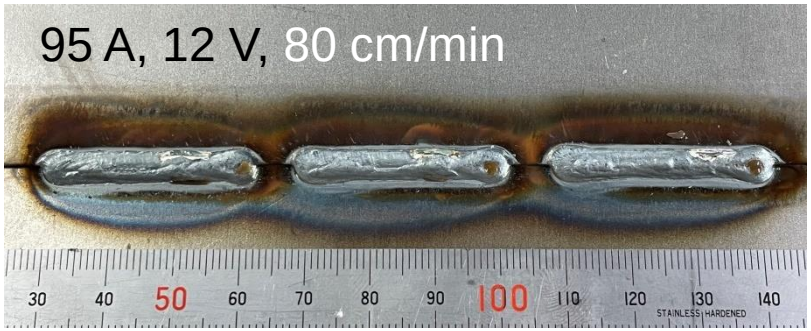
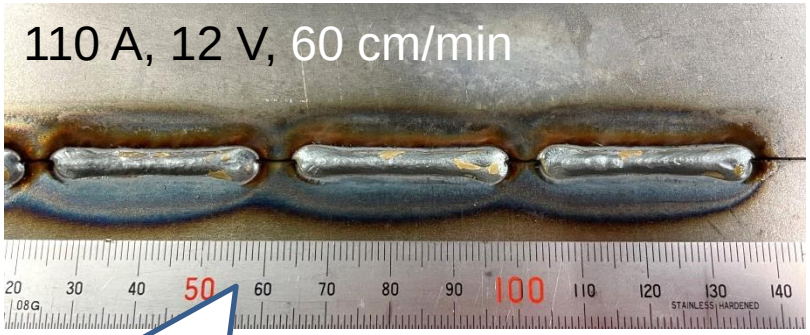
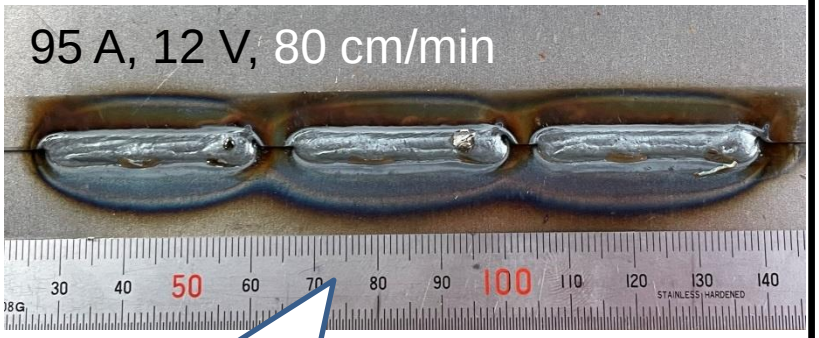






Welding Sample (Mild Steel, CO2 Welding)

Lap joint welding of 0.8 mm thick plate (wire diameter φ1.2)

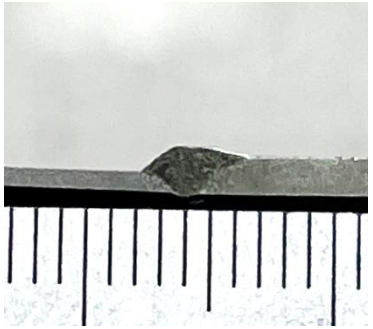
Gap	Conventional Synchro-feed	Push-arc process
0 mm		
0.8 mm		

Difficult to increase welding speed

Wide beads have been achieved

Welding Sample (Mild Steel, CO2 Welding)

Lap joint welding of 0.8 mm thick plate (wire diameter φ1.2)

Gap	Conventional Synchro-feed	Push-arc process
0 mm	 Emboss bead	 Flat and wide bead
0.8 mm	 Emboss bead	 Flat and wide bead

Welding Sample (Galvanized Sheet Steel, MAG Welding)

Conventional Synchro-feed
85 A, 16 V, 80 cm/min.
Galvanized sheet steel, thickness 1.0 mm
Butt joint (wire diameter φ1.0)

Stable beads of uniform width are formed through the action of expanding the molten pool even in the low current range,

zinc vapor discharge is accelerated, but no pit generation was observed.

Push-arc process
85 A, 16 V, 80 cm/min.
Galvanized sheet steel, thickness 1.0 mm
Butt joint (wire diameter φ1.0)

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Welding of Galvanized Sheet Steel by Push-Arc Process

By using the push-arc process, pore defects such as blowhole are expected to be reduced.

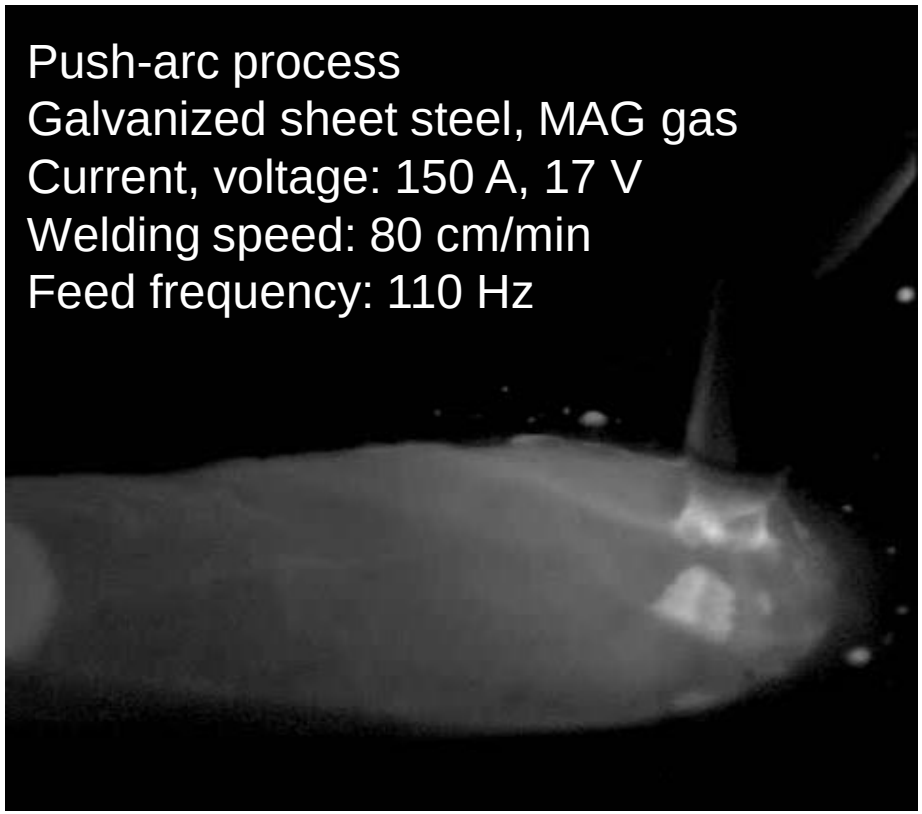
① In the push-arc process, **excess weld metal** becomes lower in height. → The time to release zinc gas mixed in is short.

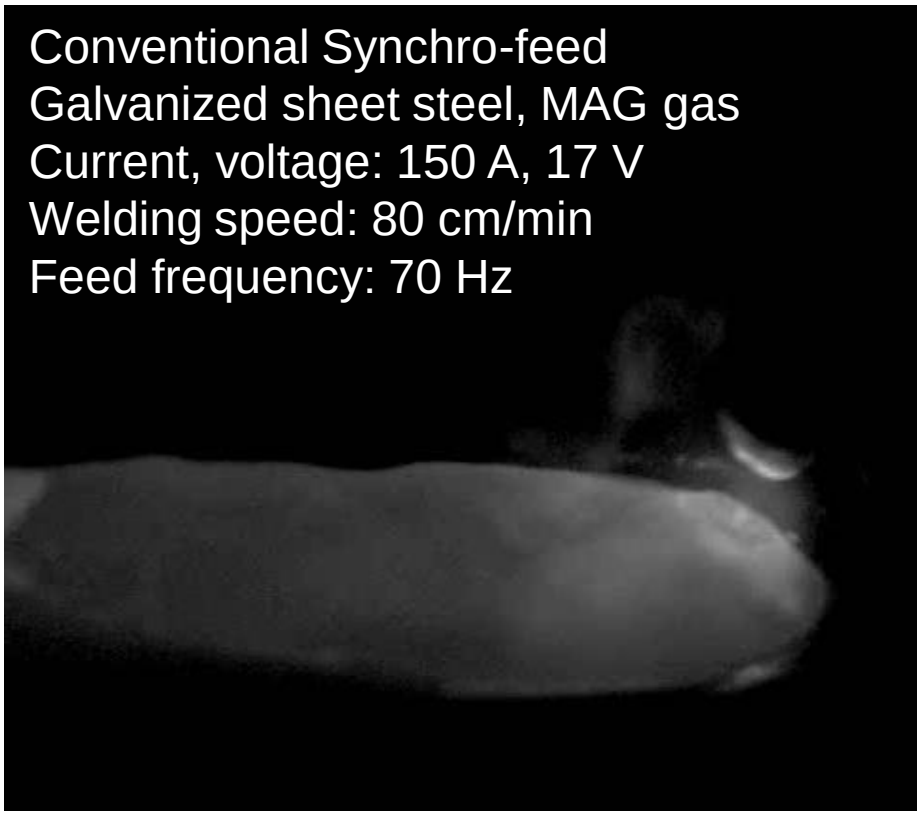
② Use **arc force** to expand the molten metal so that the bead can be flattened. → The molten metal shakes when it is expanded, which facilitates the release of gas mixed in.

③ For the push-arc process, **feed frequency** is high. → The increased number of times the molten metal is shaken makes it easy to release gas mixed in.

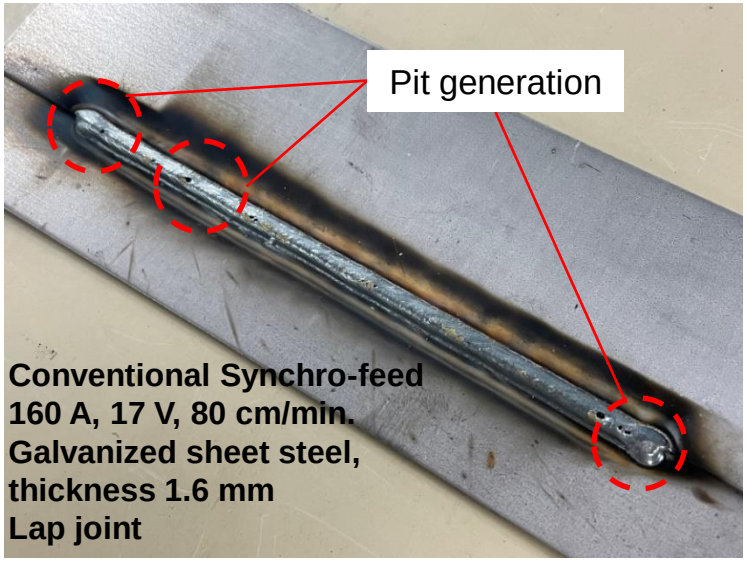
Welding of Galvanized Sheet Steel by Push-Arc Process

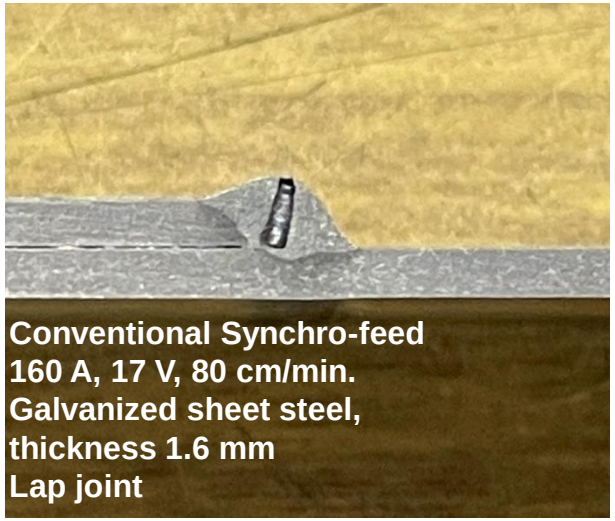
- **Verify by comparison using high-speed video.**

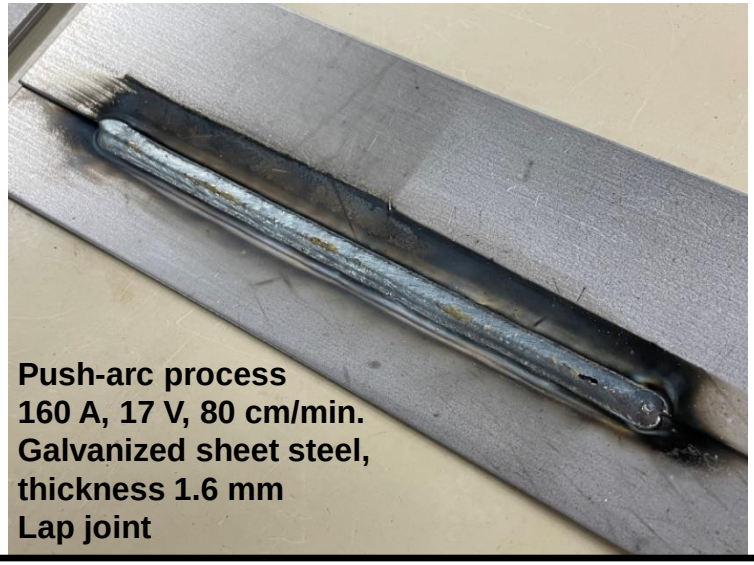


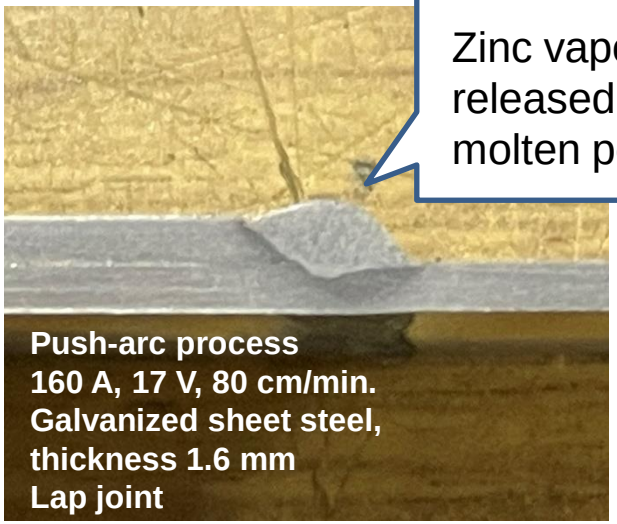


Welding Sample (Galvanized Sheet Steel, MAG Welding)





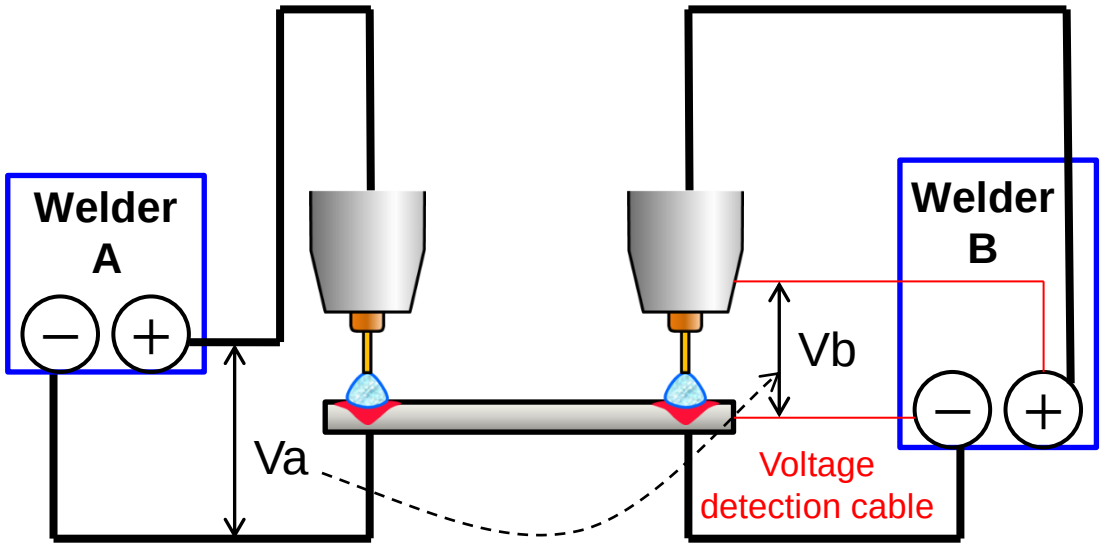




Zinc vapor is easily released when the molten pool is extended

Learning Function for Spatter Reduction by Predicting Constriction

Causes of spatter generation when welding simultaneously using multiple welders



The voltage Va affects the voltage Vb.

The voltage Va generated by welder A affects the voltage FB of welder B.

The voltage FB of welder B becomes Vb + α.
This causes deviation of the timing of low spatter control and an increase in spatter.

Learning Function for Spatter Reduction by Predicting Constriction

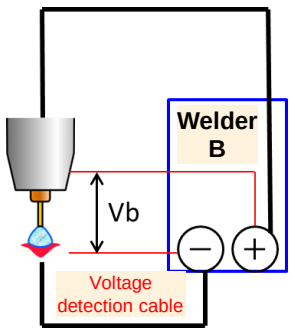
The new control is capable of reducing spatter even when welding simultaneously using multiple welders by predicting the timing of arc generation and not relying on the voltage FB.

Conventional control

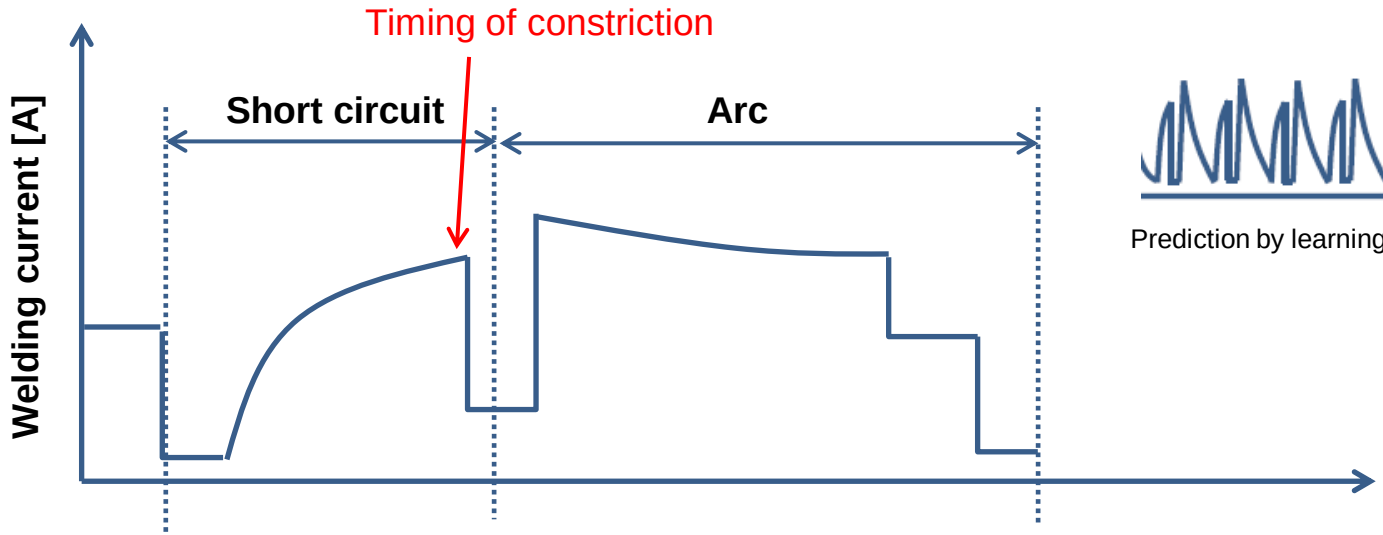
The voltage FB detects just before the arc is generated, and current is sharply reduced.

New control

The timing of generation of constriction is predicted based on the timing of arc reignition according to welding conditions and data learned from the past short-circuit cycle.

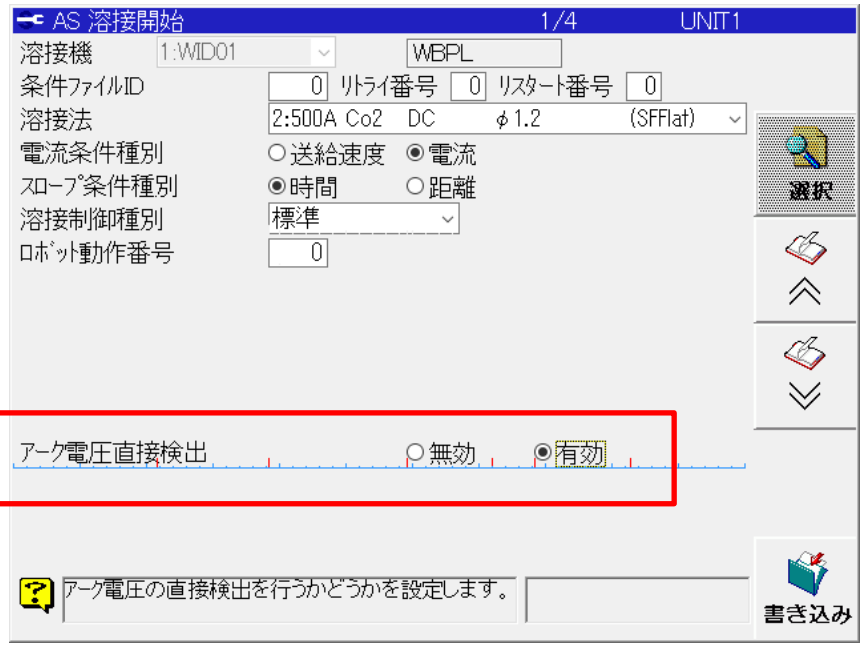


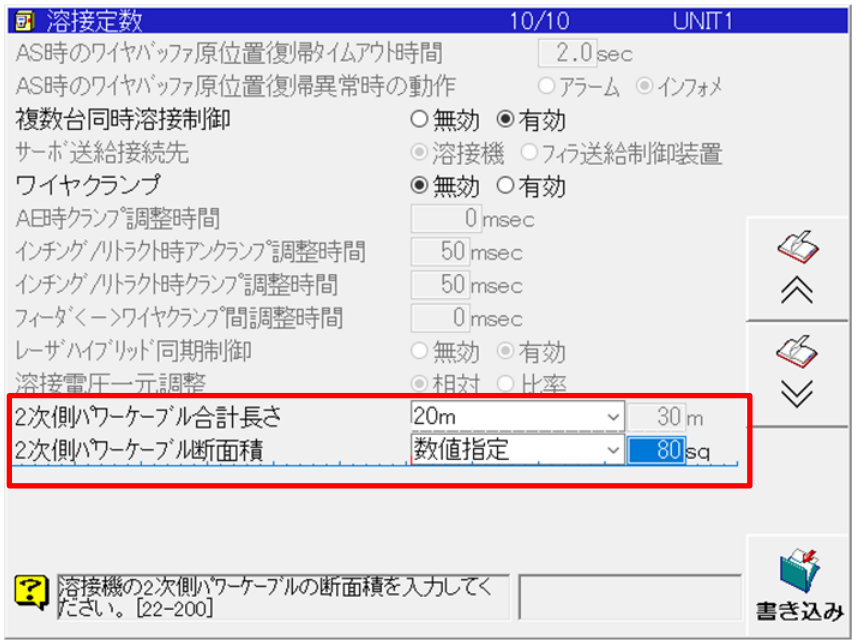
Voltage feedback



Prediction by learning data

Learning Function for Spatter Reduction by Predicting Constriction





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Summary of Push-Arc Process

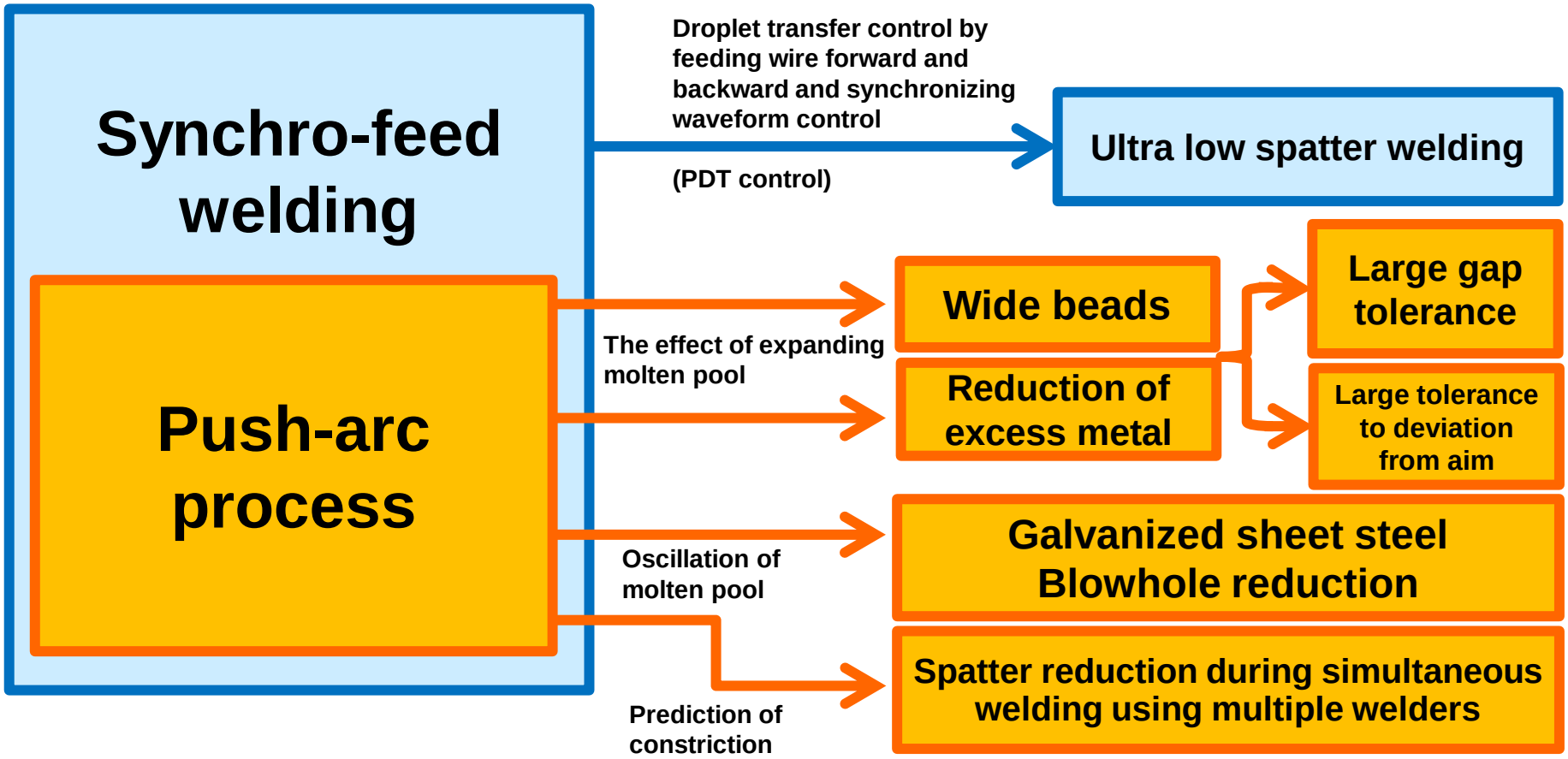
1. The push-arc process allows low spatter welding similar to conventional Synchro-feed.

2. The push-arc process is capable of forming wide beads even on thin sheets, increasing joint tolerance.

3. In the welding of galvanized steel sheets, reduction of blowholes and pits can be expected.

4. In welding with multiple welders, the predictive learning function can prevent spatter from increasing.

Summary of Push-Arc Process



The push-arc process provides high-quality welding using Synchro-feed in an even wider range of applications

New Control: Synchro-Feed Pulse

Welding process that alternates Synchro-feed welding and pulse welding

Video

- **Expansion of the scope of application by heat input control**

  Supports a wide range of plate thicknesses from 1 mm to 4 mm

- **Beautiful bead appearance**

  Beautiful scale-like beads are possible

- **Easy-to-use welding instructions**

  Average current and simple setting of pulse conditions only

Background of Development

Synchro-feed

- Maximum current 150 A
  Forward and backward feeding of wire
- Thin plate welding
  Due to low input heat, does not burn through, even on thin plates
- Emboss beads form easily

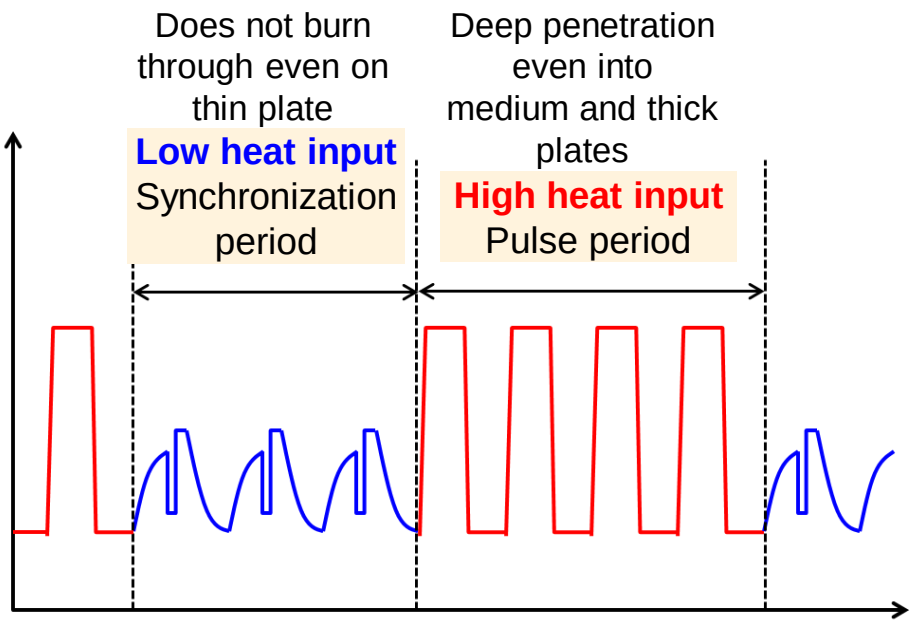
Pulse welding

- Maximum current 400 A
  Forward feeding of wire
- Medium and thick welding
  Deep penetration at high pulsed current
- A burn through occurs

Fusion

Synchro-feed pulse welding

Principles of Synchro-Feed Pulse Welding



Current waveform

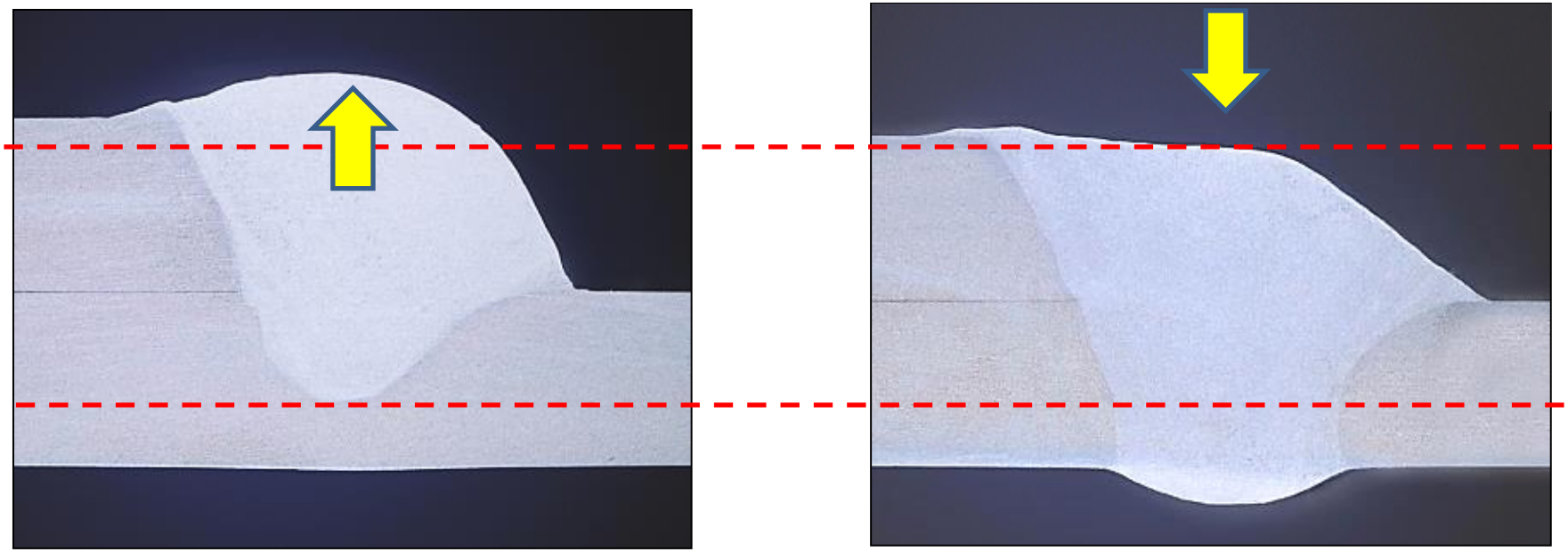
Welding process that repeats Synchro-feed and pulse at a determined frequency

Comparison of Welding Processes

	Aluminum Synchro-feed Pulse welding process	Aluminum Synchro-feed Welding process
Appropriate weld plate thickness	2.0 mm - 4.0 mm	1.0 mm - 1.5 mm
High-speed welding	200 A: 100 cm/min	130 A: 80 cm/min
Weld bead appearance	Sharp scale-like beads 	Smooth  * With weaving
Disadvantages	Slightly more spatter is generated than Synchro-feed	Emboss beads form easily due to low heat input Example) Butt welding

Function of Synchro-Feed Pulse Welding

① Pulse ratio allows adjustment of the height of excess metal and penetration



Pulse ratio 30%

* Many Synchro-feed welding sections

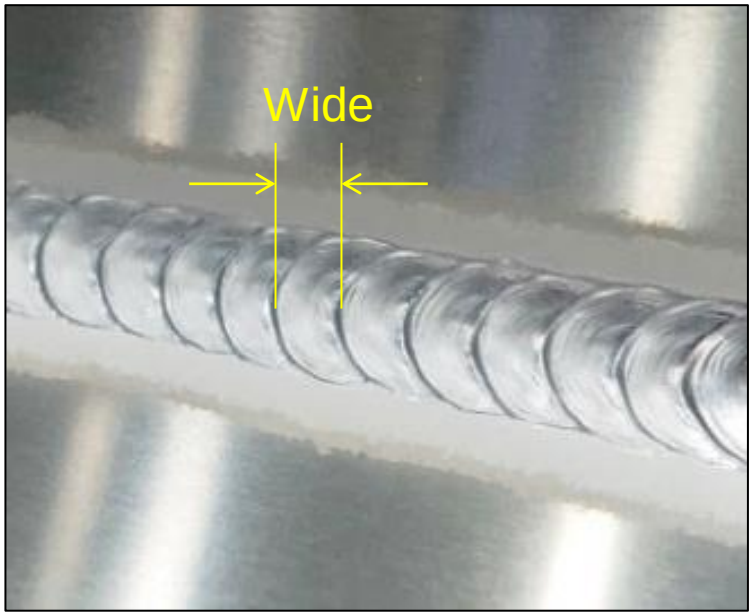
Pulse ratio 70%

* Many pulse welding sections

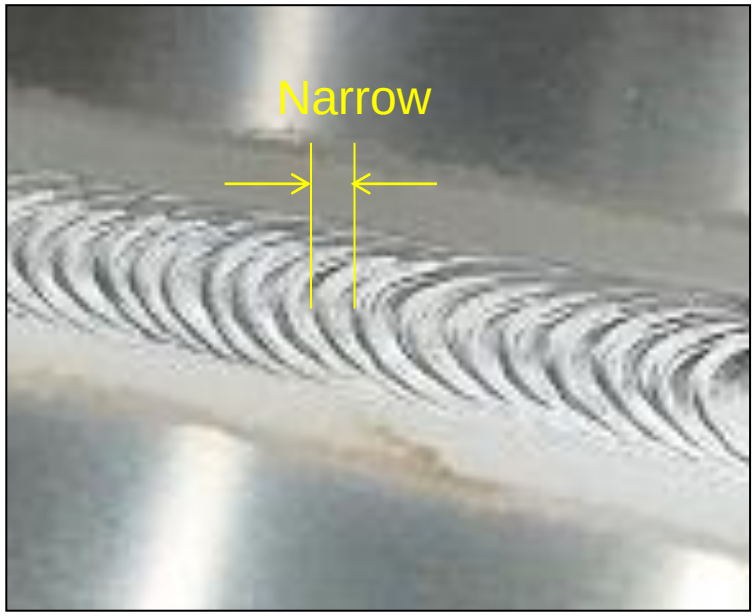
Function of Synchro-Feed Pulse Welding

② Waves can be adjusted by pulse frequency.

Small ← Pulse frequency → Large



Pulse frequency 1.5 Hz



Pulse frequency 4.0 Hz

Function of Synchro-Feed Pulse Welding

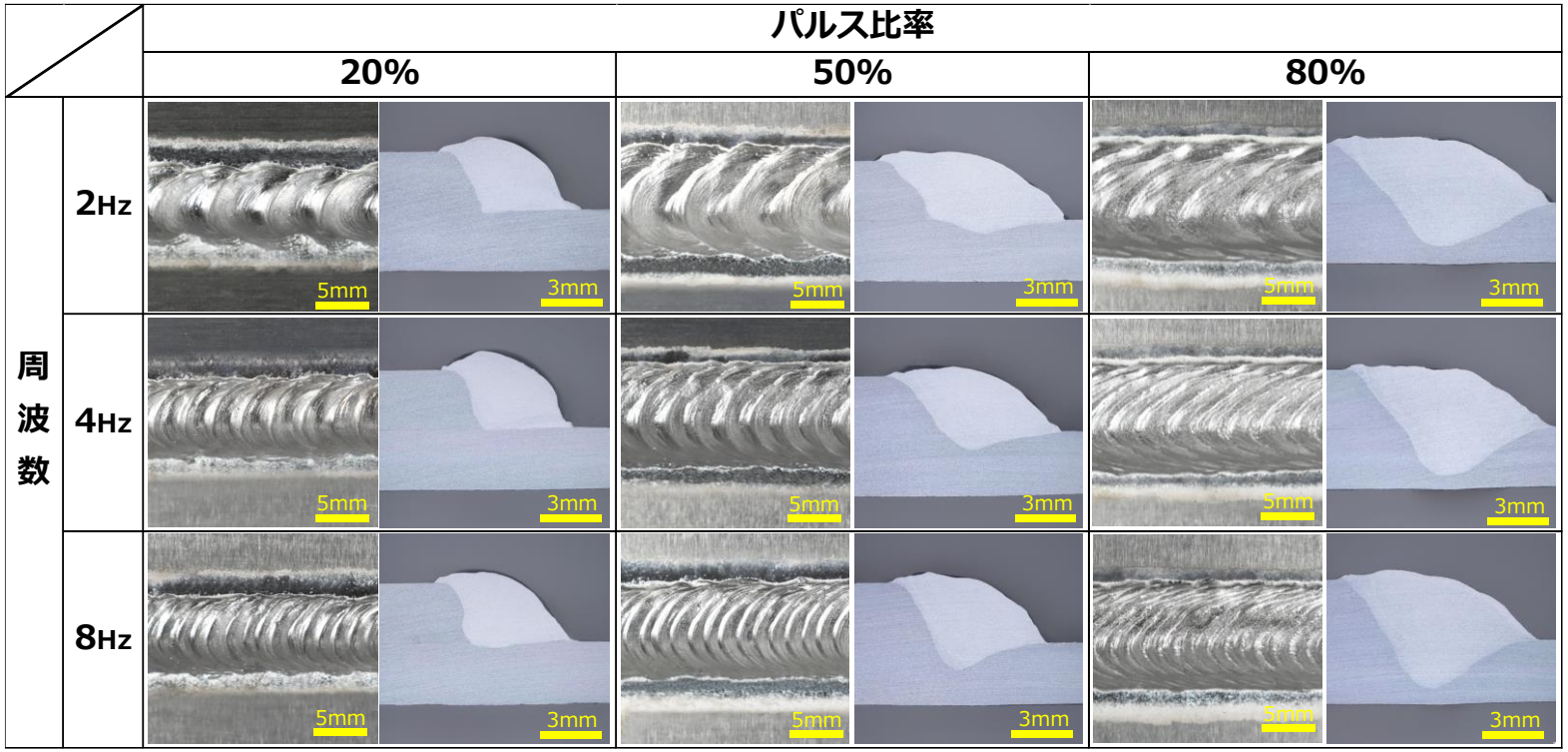
② Summary of the relationship between pulse ratio and frequency

Bead width: thin
Penetration: shallow

Bead width: wide
Penetration: deep

Waves
Spacing: wide

Waves
Spacing: narrow

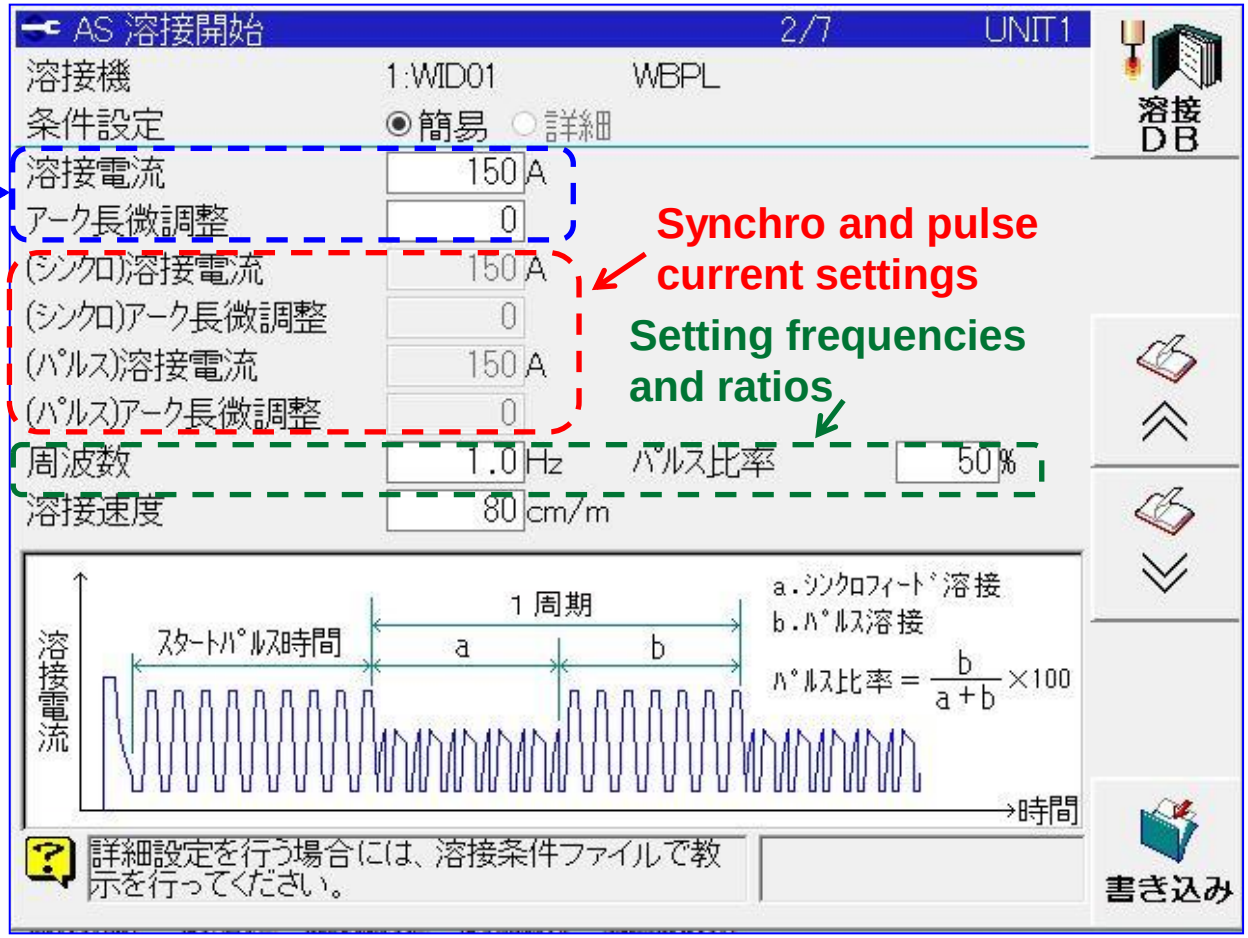


* Set current/voltage and welding speed are fixed.

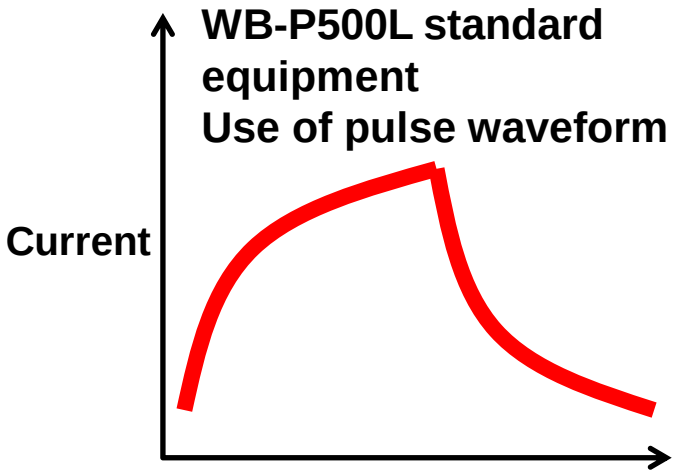
Welding conditions
Synchro side setting: 100 A/12.0 V, pulse side setting: 150 A/18.0 V, base metal: A5052 (3 mmt)
Wire: A5356 (1.2 mmφ), Shield gas: 100% Ar, Welding speed: 45 cm/min, Joint: lap

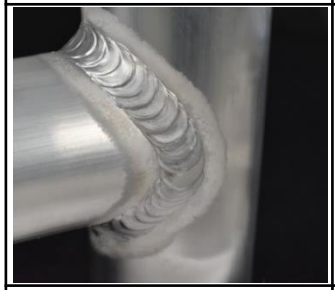
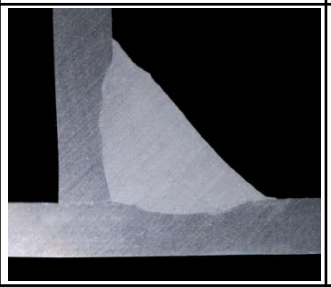
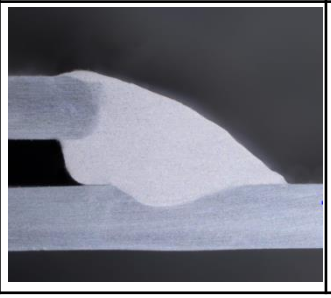
Function of Synchro-Feed Pulse Welding

③ AS commands allows easy settings of current, voltage, pulse ratio, etc.



Welding Application Examples



Bead appearance	Bead cross-section	Welding conditions
		Base metal (thickness): A5052 (3.0 mmt) Wire (diameter): A5356 (1.2 mmφ) Joint: lap Set current/voltage: (SF) 80 A/12.0 V, (PLS) 200 A/20.0 V Pulse ratio: 70% Synchro pulse frequency: 4.0 Hz Welding speed: 55 cm/min Position: horizontal
		Base metal (thickness): A6063 (2.0 mmt) Wire (diameter): A4043 (1.2 mmφ) Joint: pipe (T corner) Set current/voltage: (SF) 70 A/13.0 V, (PLS) 130 A/18.0 V Pulse ratio: 40% Synchro pulse frequency: 1.5 Hz Welding speed: 40 cm/min Position: horizontal
		Base metal (thickness): A5052 (2.0 mmt) Wire (diameter): A5356 (1.2 mmφ) Joint: lap Gap: 2 mm Set current/voltage: (SF) 80 A/12.0 V, (PLS) 140 A/18.0 V Pulse ratio: 35% Synchro pulse frequency: 8.0 Hz Welding speed: 70 cm/min, Position: horizontal

Welding Application Examples

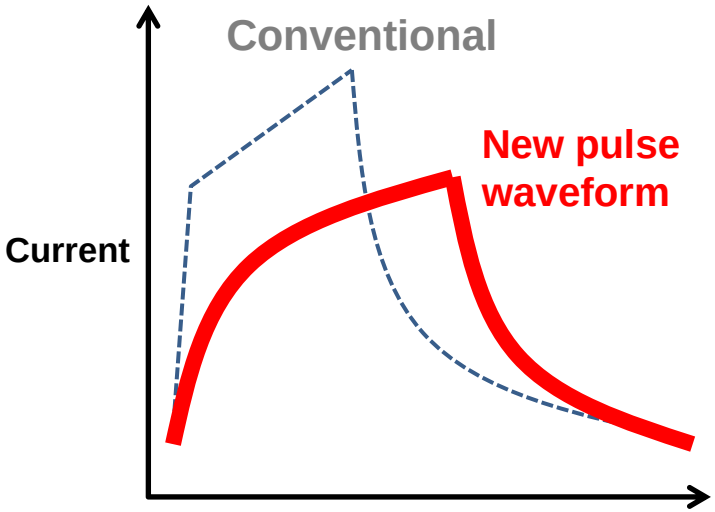
Soft Aluminium Application to pipe saddle type

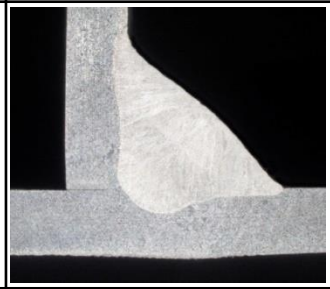
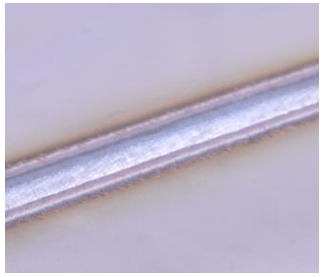
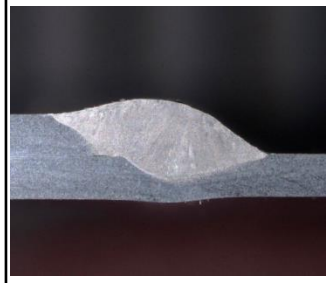
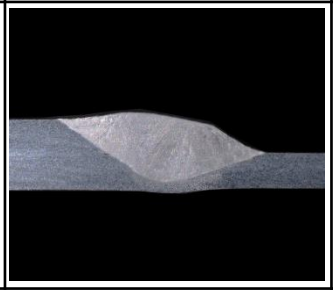
Video

Application to Stainless Steel Welding

Features

- New pulse waveform which excels at thin plate welding has been adopted
- Undercut is decreased by new pulse waveform
- Wide weld bead

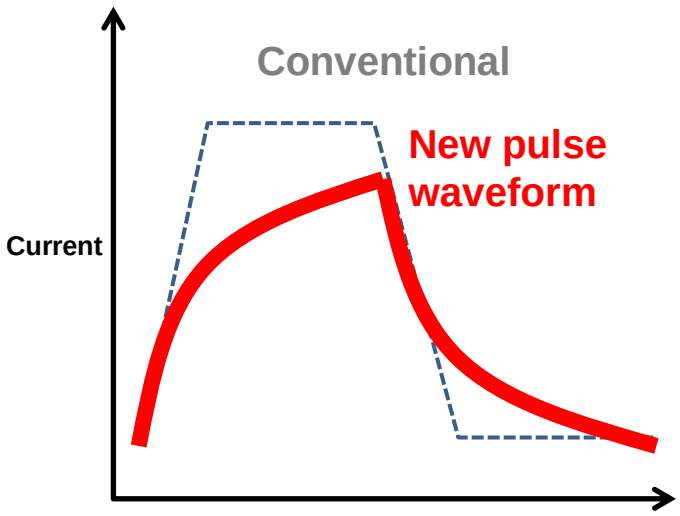


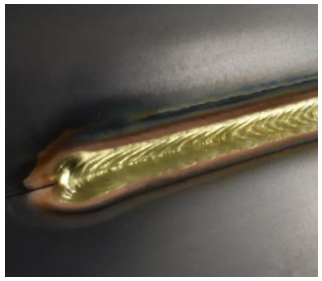
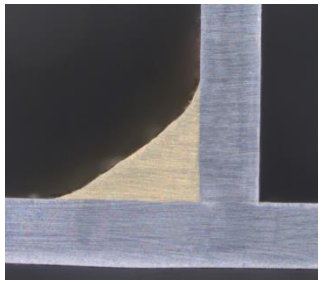
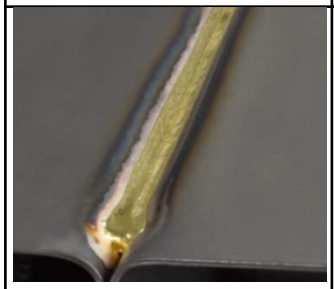
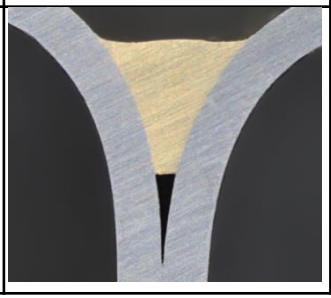
Bead appearance	Bead cross-section	Welding conditions
		Workpiece (thickness): SUS304 (2.0 mmt) Wire (diameter): SUS308 (1.2 mmφ) Joint: T corner Set current/voltage: (SF) 120 A/13.0 V, (PLS) 180 A/19.0 V Pulse ratio: 40% Synchro pulse frequency: 10 Hz Welding speed: 70 cm/min Position: horizontal, Push angle: 5°, Torch angle: 40°
		Base metal (thickness): SUS304 (1.0 mmt) Wire (diameter): SUS308 (1.2 mmφ) Joint: lap Set current/voltage: (SF) 120 A/12.0 V, (PLS) 180 A/18.0 V Pulse ratio: 40% Synchro pulse frequency: 10 Hz Welding speed: 120 cm/min Position: downward 40°, Push angle: 5°, Torch angle: 10°
		Workpiece (thickness): SUS430 (0.8 mmt) Wire (diameter): SUS430 (1.0 mmφ) Joint: lap Set current/voltage: (SF) 140 A/11.0 V, (PLS) 190 A/21.0 V Pulse ratio: 50% Synchro pulse frequency: 15 Hz Welding speed: 180 cm/min Position: downward 40°, Push angle: 5°, Torch angle: 5°

Application to Brazing

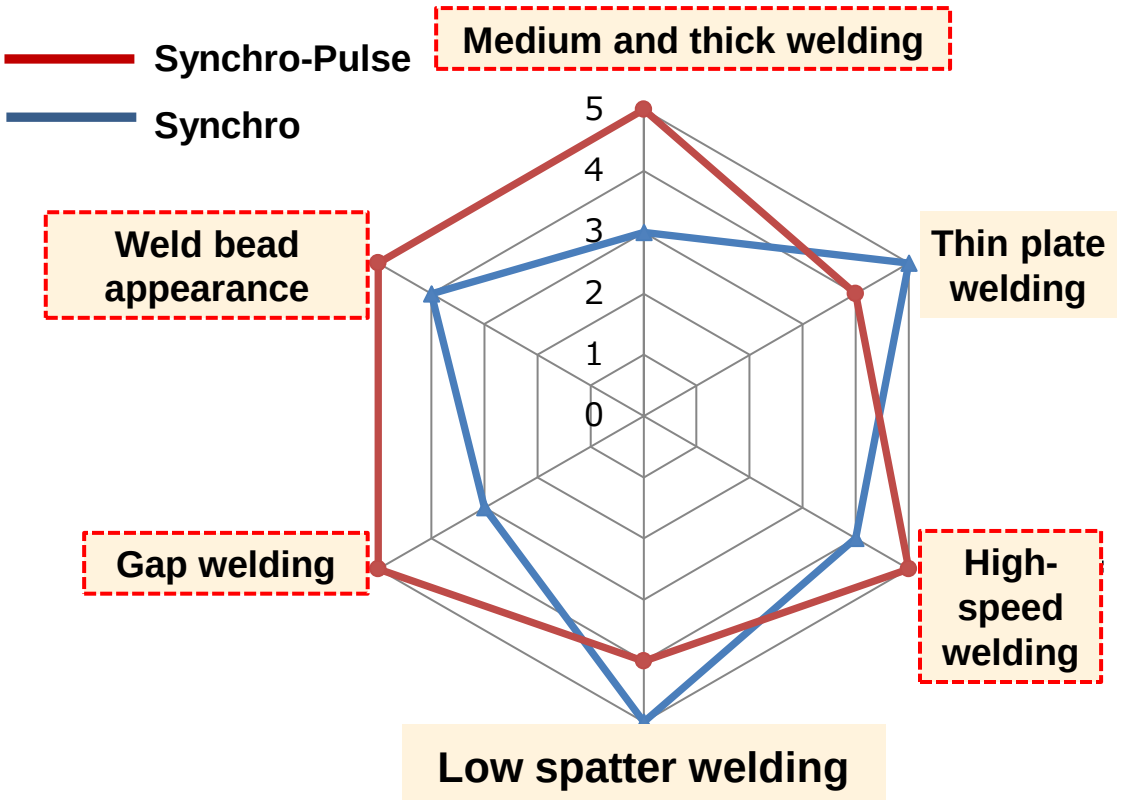
Features

- Pulse waveform which excels at thin plate welding has been adopted
- Wide weld bead
- Penetration into base metal is reduced



Bead appearance	Bead cross-section	Welding conditions
		Base metal (thickness): Spcc (2.0 mmt) Wire (diameter): CuSi (1.2 mmφ) Joint: T corner Set current/voltage: (SF) 100 A/13.5 V, (PLS) 130 A/18.5 V Pulse ratio: 50% Synchro pulse frequency: 10 Hz Welding speed: 110 cm/min Position: horizontal, Push angle: 10°, Torch angle: 40°
		Base metal (thickness): Spcc (1.0 mmt) Wire (diameter): CuSi (1.0 mmφ) Joint: double flare Set current/voltage: (SF) 100 A/13.0 V, (PLS) 140 A/21.5 V Pulse ratio: 50% Synchro pulse frequency: 12 Hz Welding speed: 150 cm/min Position: horizontal

Guide for Adaptation of Synchro-Feed Pulse



[Main features of Synchro-Pulse]

■ **Extended heat input control range**

- Capable of welding medium and thick plates that were difficult to weld with Synchro-feed (3 - 4mm)
- Easy to set welding conditions even for thin plate gap welding
- High-speed welding allows formation of a wide range of weld beads

■ **Formation of scale-like beads**

- Capable of forming beautiful and sharp scale-like beads

Summary of Features of Welding Control

Synchro-feed welding

Droplet transfer control by feeding wire forward and backward and synchronizing waveform control

(PDT control)

→ Ultra low spatter welding

Push-arc process

Effect of extending molten pool

→ Wide beads

→ Reduction of excess metal

Wide beads → Large gap tolerance

Reduction of excess metal → Large tolerance to deviation from aim

Oscillation of molten pool

→ Galvanized sheet steel Blowhole reduction

Prediction of constriction

→ Spatter reduction during simultaneous welding using multiple welders

Synchro-feed Pulse

Heat input/ penetration control

→ Supports a wide range of plate thicknesses

Pulse frequency Adjustment

→ Forms beautiful scale-like beads

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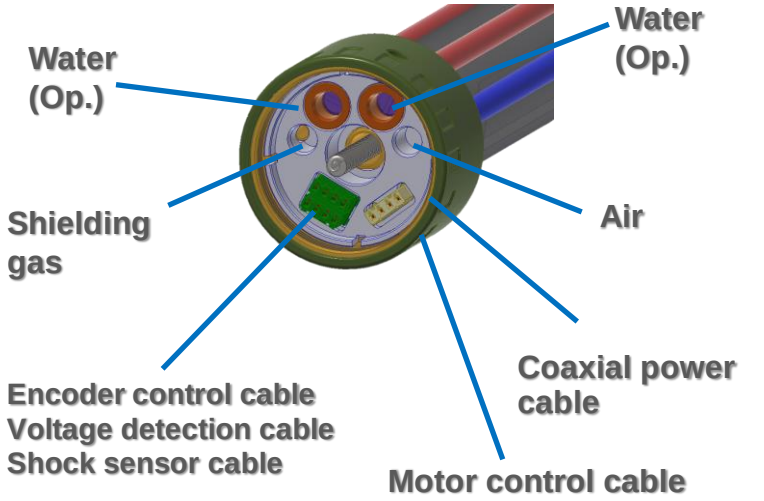
Simple and Easy Connection

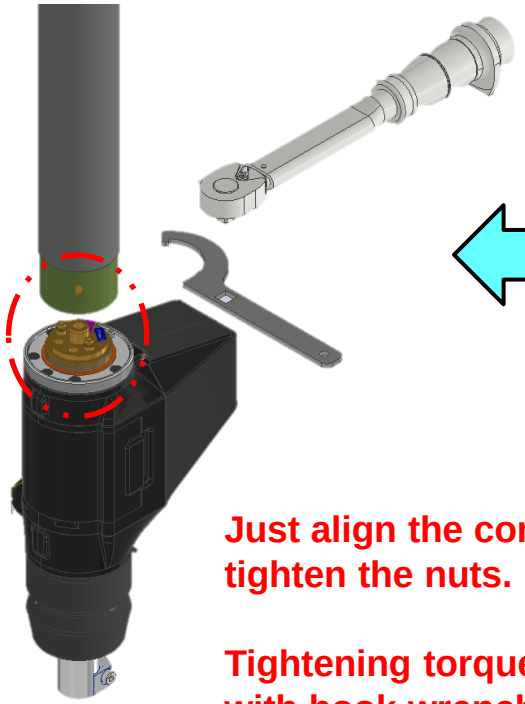
Composite control cables reduce connection work hours by 95%.

Integrated cables and hoses

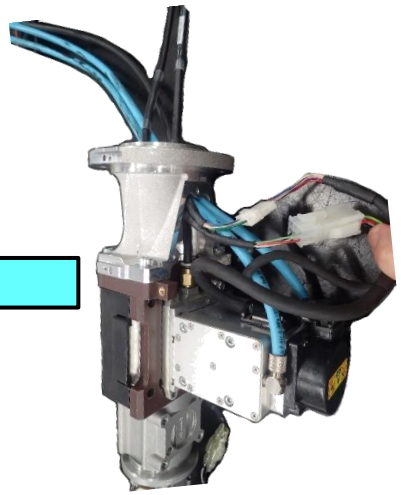


Patent application pending

New product



Conventional



Just align the connector parts and tighten the nuts.

Tightening torque can be controlled with hook wrench (for 9.6 square hole)

- Cables and hoses between pull F and coaxial PC are collected in one place
- Connection can be made in one action and work is completed in about 2 minutes. (Previously, it took more than 30 minutes)
- Even an inexperienced user can install it easily and securely.

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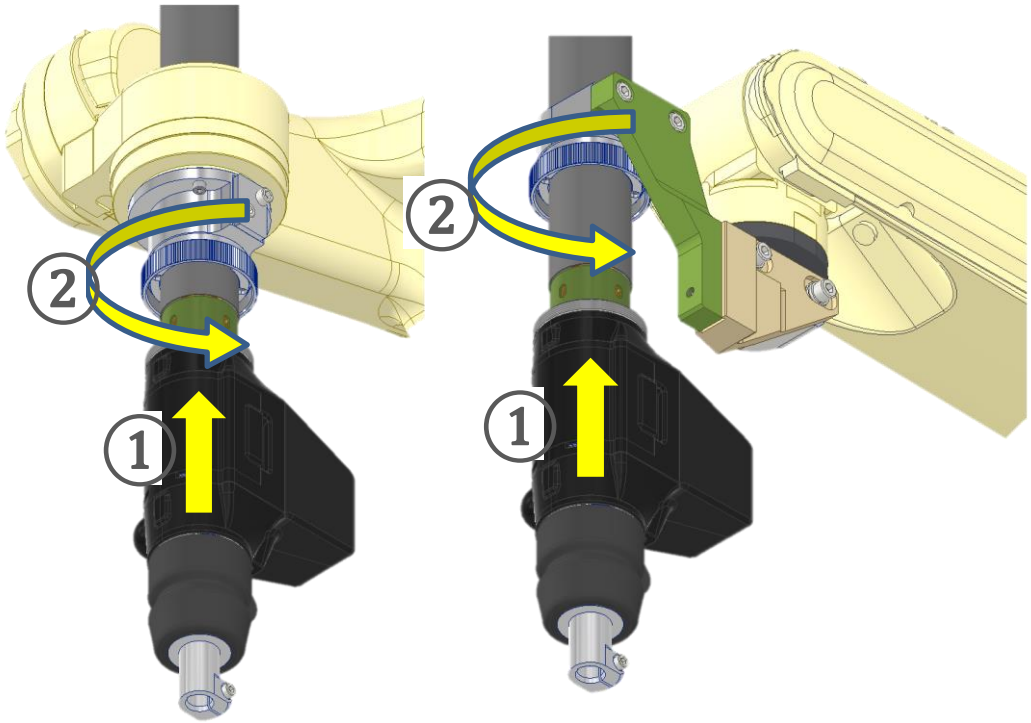
Simple and Easy Connection

- Can be easily installed in the bracket in two actions.

① Insert pull F, coaxial PC into bracket

② Tighten and secure the nut.

Connection work hours:
about 1 minute



NB6 type NV8 type

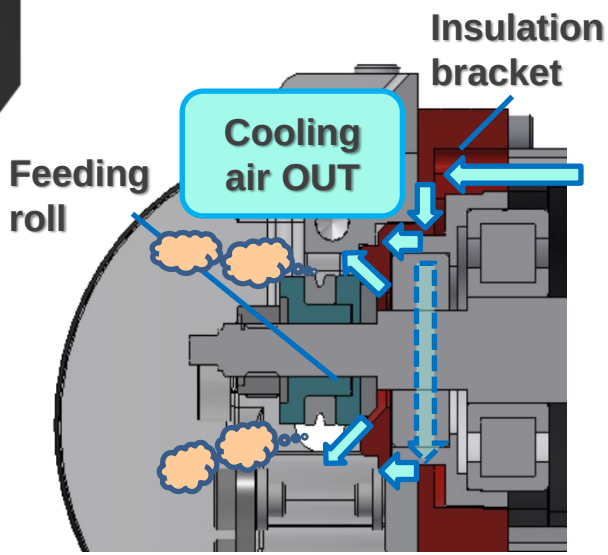
Easy Maintenance

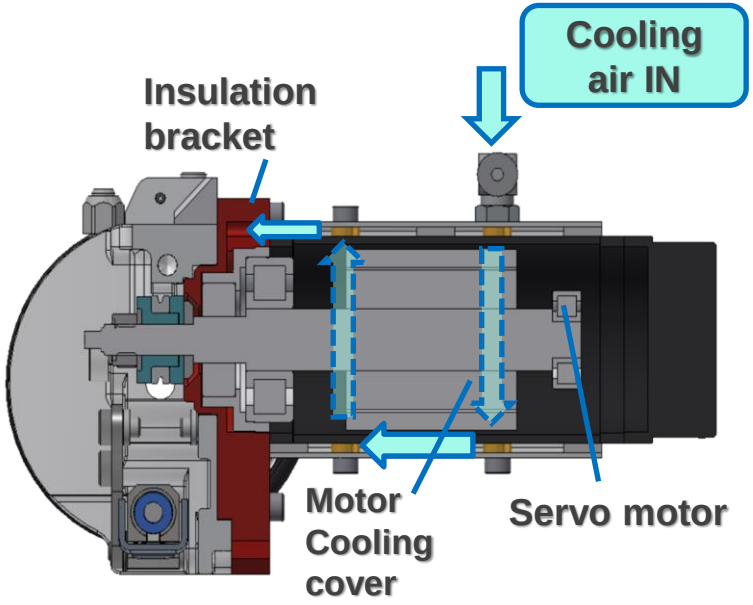
Auto-cleaning function reduces cleaning frequency of wire feeder by 90%.

Equipped with air purge function that automatically discharges wire shavings

Cleaning frequency reduced to 1/12!
(Once/week → Once/3 months)

- **Reduces time and effort required for cleaning and problems caused by forgetting to clean, and provides productivity improvement to customers.**





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Two Types of Synchro-Feed to Choose From

Synchro-feed

Multi-material

Reel・Pack wire

500 A Power supply

Synchro-feed Lite

Mild steel
Stainless steel

Pack wire

350 A Power supply

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Specification Comparison

Items	Synchro-feed Evolution	Synchro-feed Evolution Lite
Main components	Wire buffer Pull feeder Push feeder	Pull feeder
Applicable materials	Mild steel, stainless steel, Aluminum	Mild steel, stainless steel
Wire stock method	Pack/reel	Pack wire
Supported welders	WB-P500L	WB-P350L
Maximum welding current	CO2: 400 A MAG: 350 A	CO2: 280 A MAG: 350 A

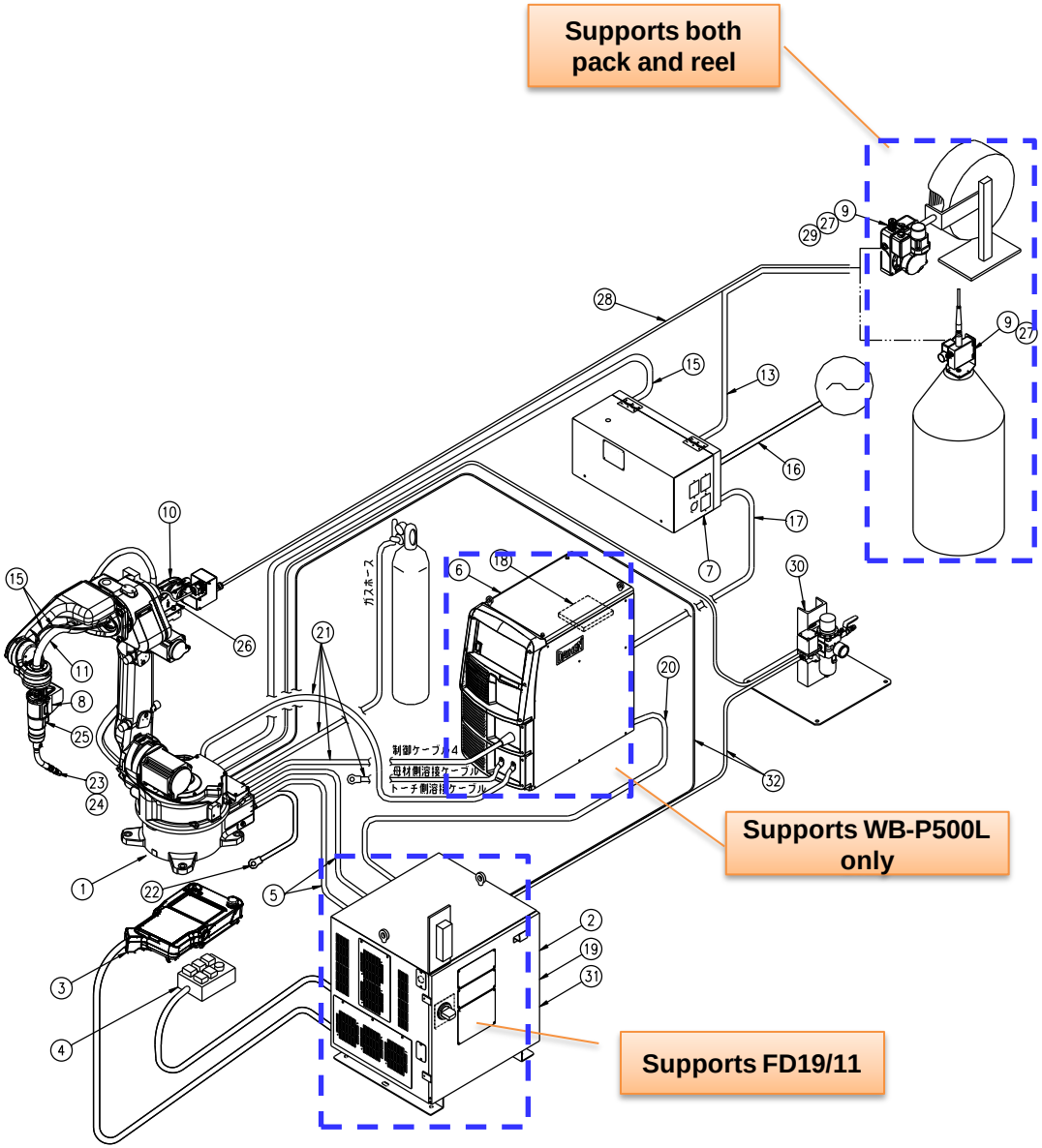
Synchro-Feed Configuration Comparison Table

		Synchro-feed Evolution	Synchro-feed I	Synchro-feed Evolution Lite	Synchro-feed I Lite
1	Manipulator	NB6/NB6L/NV8/NV8L/NV25			
2	Robot controller	FD19	FD19 / FD11	FD19	FD19
3	Welding power supply	WB-P350L/WB-P500L	WB-P500L	WB-P350L / WB-P500L	WB-P350L
4	Wire feed control unit	AFCA-S2W04			
5	Pull feeder	AFPS-2511	AFPS-2503	AFPS-2511	AFPS-2503
6	Coaxial power cable	L-12055 (for B6) L-12056 (for B6L) L-12057 (for NV8 and NV25) L-12058 (for NV8L)	L-11733 (for B6) L-11622 (for V8/V25) L-11880 (for B6L) L-11634 (for V8L)	L-12055 (for B6) L-12056 (for B6L) L-12057 (for NV8 and NV25) L-12058 (for NV8L)	L-11733 (for B6) L-11622 (for V8/V25) L-11880 (for B6L) L-11634 (for V8L)
7	Wire buffer	L-11610		Unnecessary (L-11610) Changed to mounting bracket	
8	Push feeder	AFS-2301		Unnecessary (AFS-2301)	
9	Conduit	L10597□			
10	High duty cycle kit	L11741H			

* To distinguish it from Synchro-feed Evolution, the current Synchro-feed is referred to as Synchro-feed I in this document.

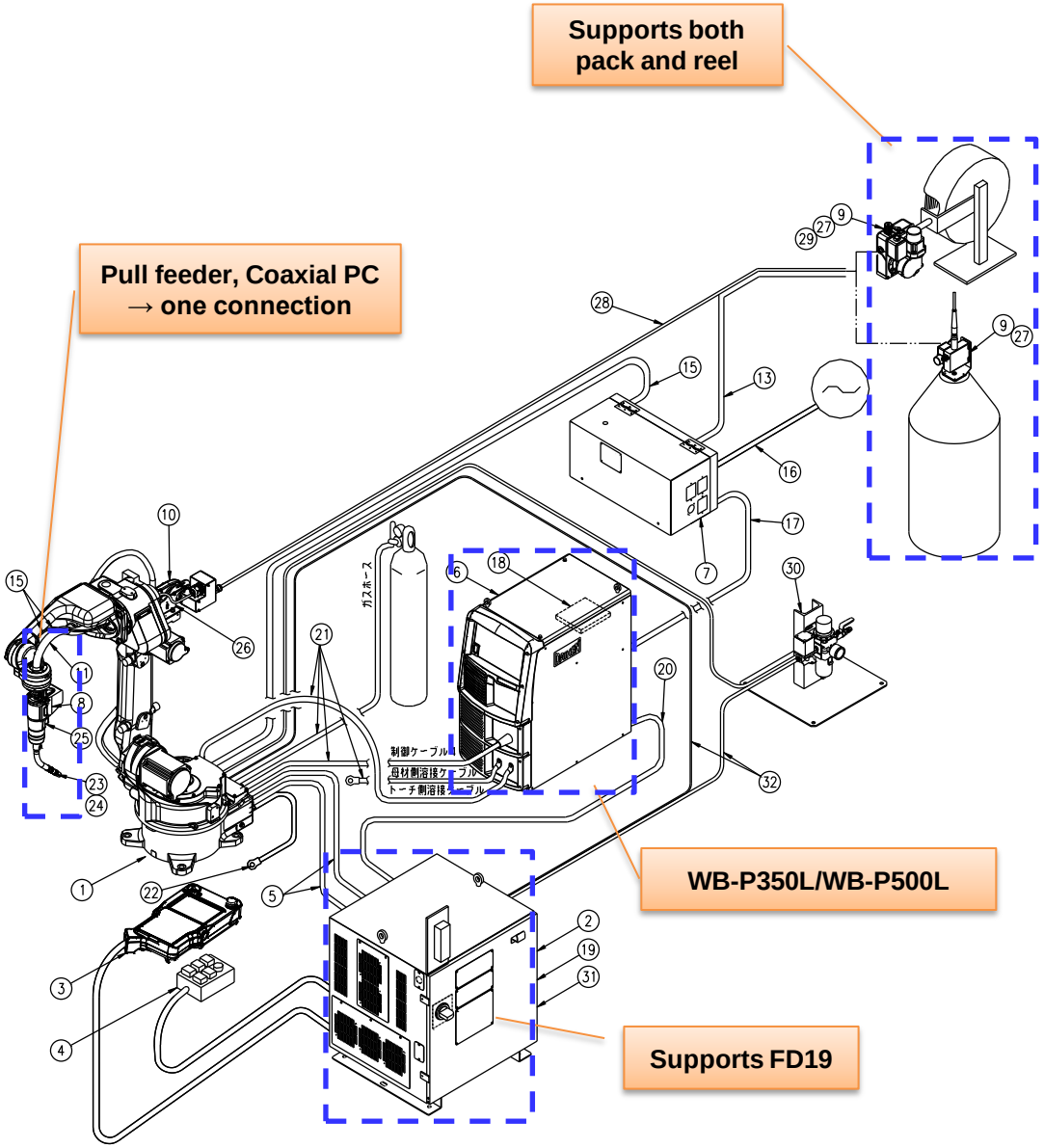
* Support for FD11 other than Synchro-feed I is being planned

Synchro-Feed I System Configuration



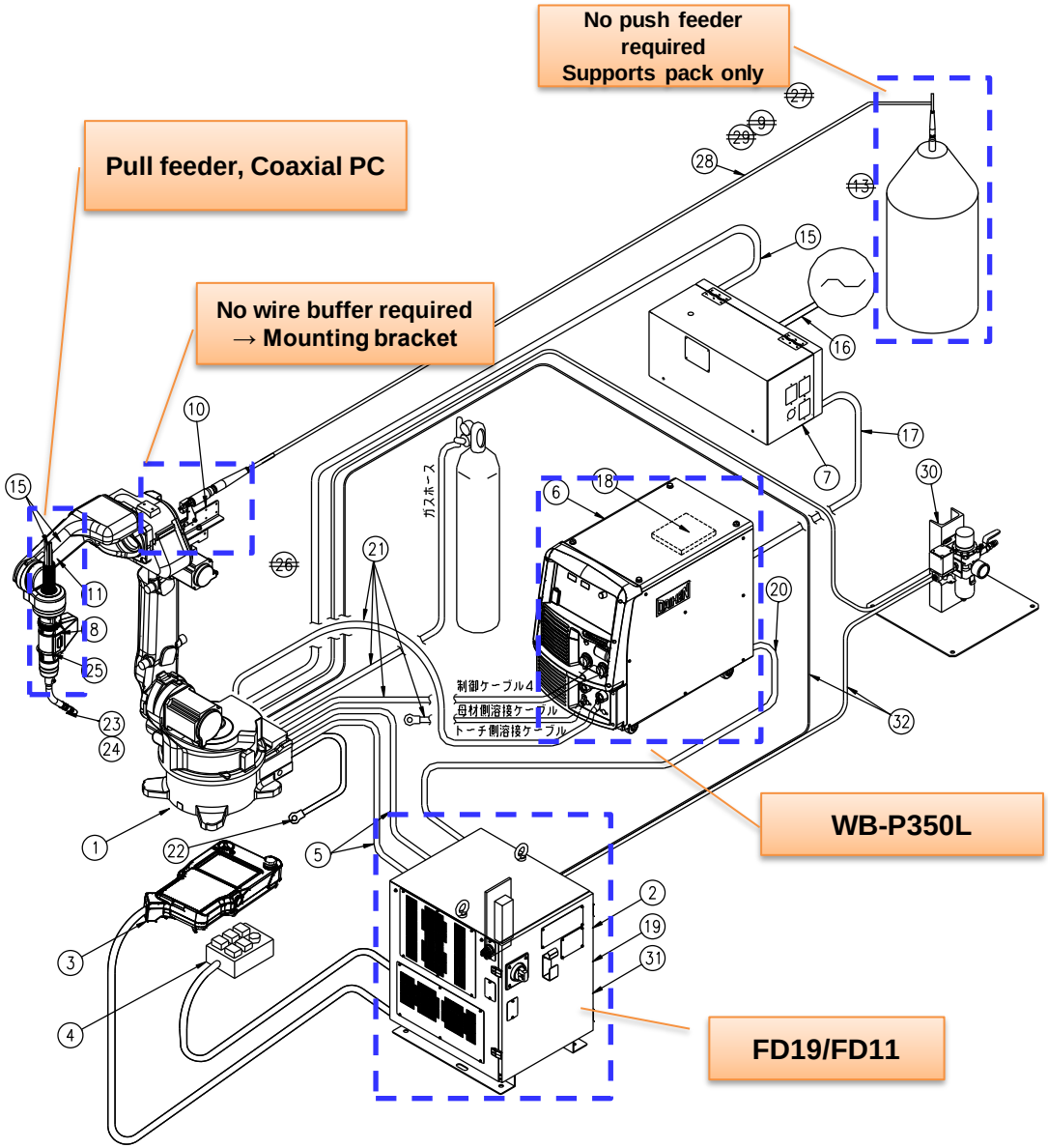
1	Manipulator	NB6/NB6L/NV8/NV8L/NV25
2	Robot controller	FD19 / FD11
3	Welding power supply	WB-P500L
4	Wire feed control unit	AFCA-S2W04
5	Pull feeder	AFPS-2503
6	Coaxial power cable	L-11733 (for B6) L-11622 (for V8/V25) L-11880 (for B6L) L-11634 (for V8L)
7	Wire buffer	L-11610
8	Push feeder	AFS-2301
9	Conduit	L10597□
10	High duty cycle kit	L11741H

Synchro-Feed Evolution System Configuration



1	Manipulator	NB6/NB6L/NV8/NV8L/NV25
2	Robot controller	FD19
3	Welding power supply	WB-P350L/WB-P500L
4	Wire feed control unit	AFCA-S2W04
5	Pull feeder	AFPS-2511
6	Coaxial power cable	L-12055 (for B6) L-12056 (for B6L) L-12057 (for NV8 and NV25) L-12058 (for NV8L)
7	Wire buffer	L-11610
8	Push feeder	AFS-2301
9	Conduit	L10597☐
10	High duty cycle kit	L11741H

Synchro-Feed I Lite System Configuration



1	Manipulator	NB6/NB6L/NV8/NV8L/NV25
2	Robot controller	FD19
3	Welding power supply	WB-P350L
4	Wire feed control unit	AFCA-S2W04
5	Pull feeder	AFPS-2503
6	Coaxial power cable	L-11733 (for B6) L-11622 (for V8/V25) L-11880 (for B6L) L-11634 (for V8L)
7	Wire buffer	Unnecessary (L-11610) Changed to mounting bracket
8	Push feeder	Unnecessary (AFS-2301)
9	Conduit	L10597□
10	High duty cycle kit	L11741H

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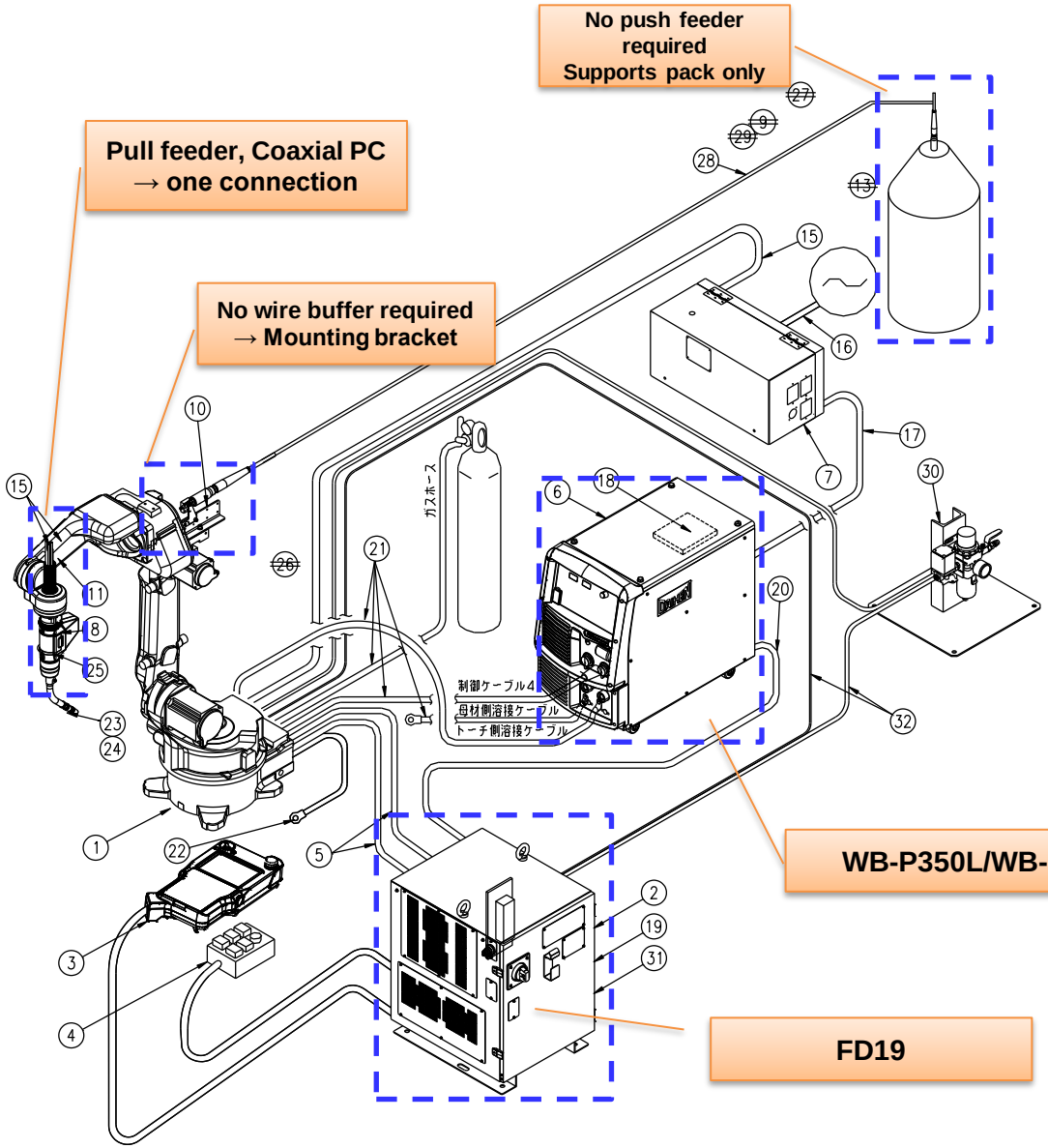
Synchro-Feed Evolution Lite System Configuration



1	Manipulator	NB6/NB6L/NV8/NV8L/NV25
2	Robot controller	FD19
3	Welding power supply	WB-P350L / WB-P500L
4	Wire feed control unit	AFCA-S2W04
5	Pull feeder	AFPS-2511
6	Coaxial power cable	L-12055 (for B6) L-12056 (for B6L) L-12057 (for NV8 and NV25) L-12058 (for NV8L)
7	Wire buffer	Unnecessary (L-11610) Changed to mounting bracket
8	Push feeder	Unnecessary
9	Conduit	L10597□
10	High duty cycle kit	L11741H

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