

Possibilities and limitations using cold MIG/MAG process variants

Cold welding – i.e. an anomaly...

Increasing demands for low heat input welding, many new power source concepts are launched that offer “cold” or even “ice cold” welding

BENEFITS with low heat input welding

- ✓ spatter free short arc welding
- ✓ minimized component distortions
- ✓ increased gap bridging ability
- ✓ enhanced melt pool control, root welding without backing
- ✓ increased weldability for advanced materials, mixed material combinations and various surface coatings
- ✓ possibilities to weld thinner gauge materials

Concepts for cold MIG/MAG welding

- ❑ **pulsed spray metal transfer**
(current pulses are used to achieve a controlled spray transfer, less current results in lower heat input)
- ❑ **AC-pulse**
(negative polarity will induce more heat on the electrode instead of the weld pool, less heat is introduced to the weld)
- ❑ **advanced power source regulations**
(dynamic feed back control that can limit current surge at short circuit resulting in lower heat input)
- ❑ **electrode reversing/oscillation** at short circuit events will facilitate droplet detachment and hence a current free metal transfer with lowered heat input

and also combinations of these

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Suppliers of “cold” MIG/MAG welding equipment

- ❑ **pulsed spray / short circuit metal transfer**
 - ESAB Aristo SuperPulse
- ❑ **AC-pulse**
 - OTC-Daihen AC-MIG
 - Cloos Cold Weld / Qineo Champ AC
- ❑ **advanced power source regulations**
 - EWM coldArc
 - Lincoln STT (surface tension transfer)
 - Miller RMD (regulated metal deposition)
 - Kemppi WiseThin (FastRoot)
 - Migatroni IntelliArc
 - Merkle ColdMIG
 - Panasonic SP-MAG
- ❑ **electrode reversing/oscillation**
 - Fronius CMT (cold metal transfer)
 - Fronius Advanced CMT (combined with polarity reversal)
 - SKS microMIG

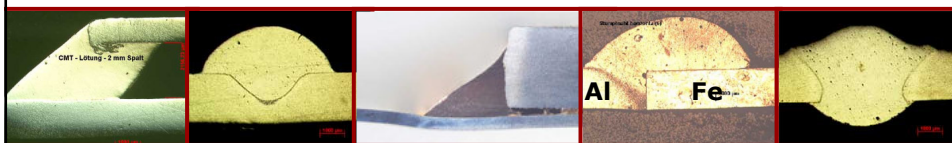
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Experiences using cold processes within "Centre for Joining&Structures"

Examples from use of:

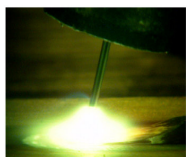
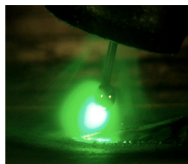
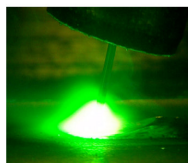
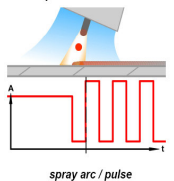
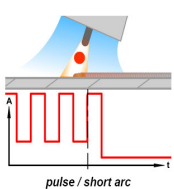
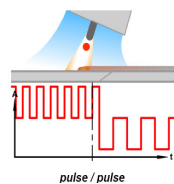
- Fronius CMT
- EWM ColdArc



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ESAB / Superpulse



Primary and secondary phase,
One arc type can be applied in each phase

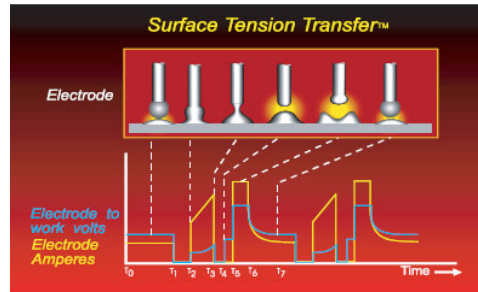
Examples:

- pulse/pulse
- pulse/short arc
- spray arc/pulse
- spray arc/short arc

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Lincoln STT (Surface Tension Transfer®)



Wave Form Control Technology™ to control current precisely and rapidly during the entire welding cycle.

The power source adjusts current automatically to the instantaneous heat requirements of the arc, i.e. neither constant current (CC) nor constant voltage (CV).

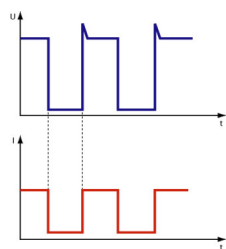
- ✓ Improved weld quality
- ✓ lower heat input and less oxidization.
- ✓ Better fusion - precise control of amperage
- ✓ Less spatter, better deposition efficiency
- ✓ Open root joints for pipe and pressure vessels.
- ✓ Less material distortion and burn-through

new generations
STT II (pipeline)
STT III (automotive)

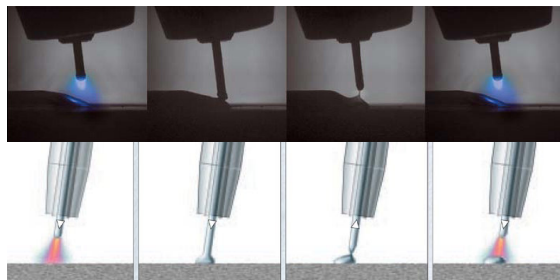
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CMT "A revolution in material joining"



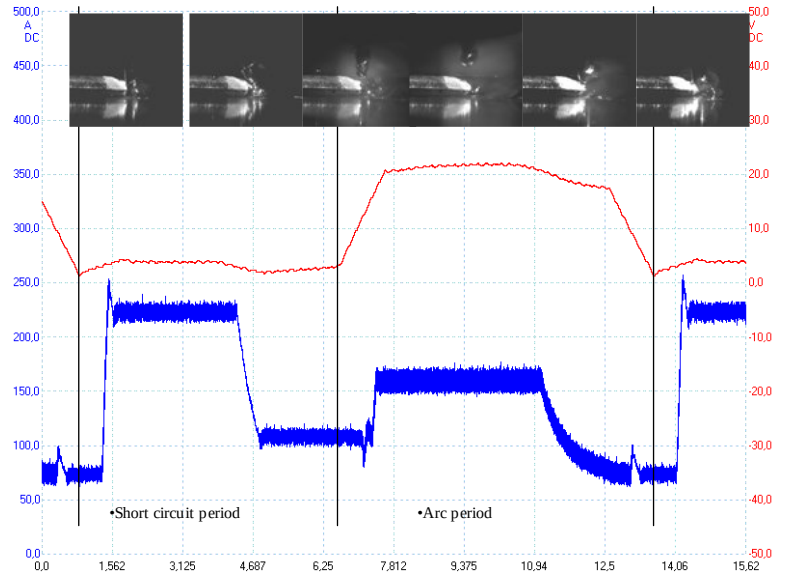
1. Wire movement is incorporated directly in the process control
2. Metal transfer at almost zero current
3. The backward movement of the wire assists droplet detachment



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Measured CMT current characteristics

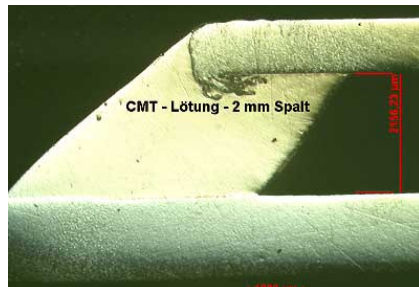


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Characteristics of the CMT Process – Gap Bridging Ability

- Lower thermal input results in less distortion and high gap bridging ability



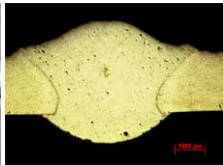
Base metal	DC01 galvanised
Sheet thickness	0.8 / 1.5 mm
Filler metal	CuSi3 / 1.0 mm
Shielding gas	Argon
Welding speed	1.0 m/min (39.37"/min)

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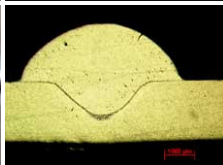
Characteristics of the CMT Process – Narrow Cross Sections

- Narrow and high weld cross-sections with pure CMT process due to low thermal input.



Dip arc

Wire feed speed	5.0 m/min
Welding current	96 A
Welding voltage	17.0 V



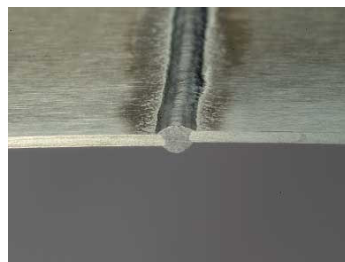
CMT

Wire feed speed	5.0 m/min
Welding current	84 A
Welding voltage	13.5 V

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Application – Thin-Sheet Welding



- Aluminium butt weld
- Sheet thickness 0.8 mm
- Welding speed 1.50 m/min (59"/min)
- Welding without backing support
- Secure root fusion without collapse of the root run

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Application – Joining of Thick and Thin Sheets

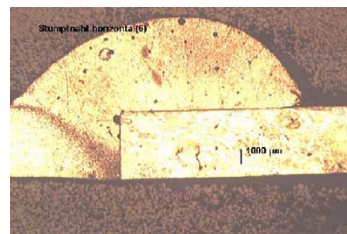


- Aluminium overlap weld
- Sheet thickness 0.8 and 4.5 mm
- Welding speed 50 cm/min (19,7"/min)
- Filler metal CuSi3
- Joining of sheets with very different thicknesses

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Application – Arc Joining of Steel and Aluminium

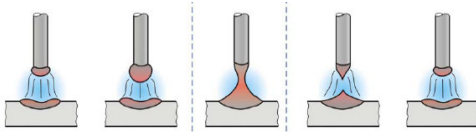
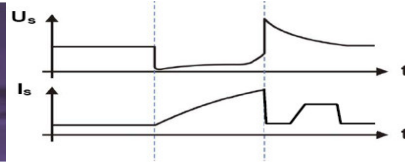
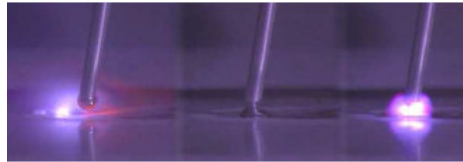


- Overlap weld
- Sheet thickness 1 mm
- Welding speed 70 cm/min (27,6"/min)
- Principle:
Aluminium-side welding
Steel-side brazing
- Requirement: galvanised steel sheet
($> 10 \mu\text{m}$)

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coldArc® (AlphaQ) "the new era in MIG/MAG welding"

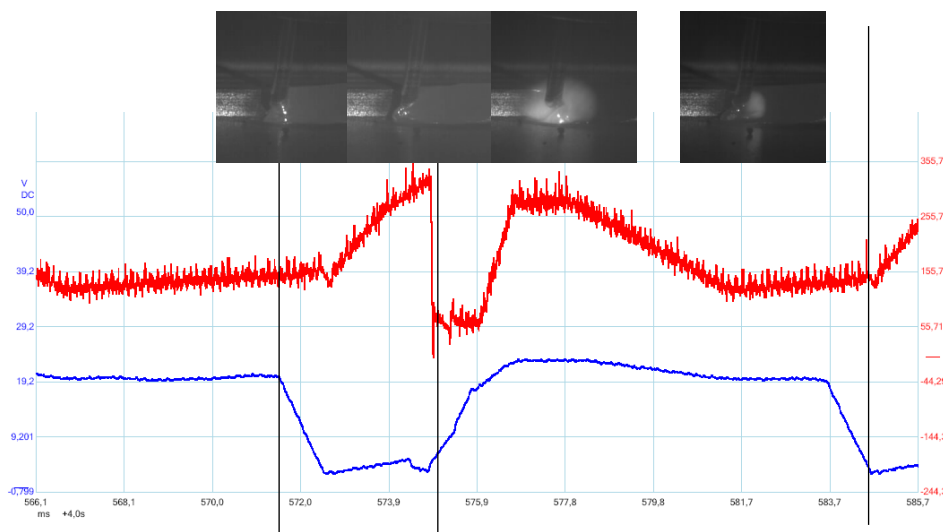


With this modified short arc the dip transition is controlled by using a new type of highly dynamic inverter switching combined with very fast digital process control so that the peak power is drastically reduced when the arc is reignited.

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Measured coldArc current characteristics



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coldArc® Applications

Thin sheet welding

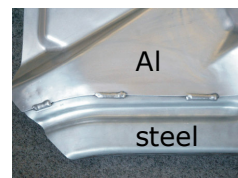
By minimizing the arc power, it is possible to join even thinnest sheets of 0.3 mm

MIG brazing

For MIG brazing now also zinc and AlSi filler can be used alternatively to copper alloys

Mixed joints

The digital, extremely fast process control allows mixed joints of light metal and steel



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Cloos “Cold Weld”

synergy-controlled AC-pulsed power source
QINEO® CHAMP AC

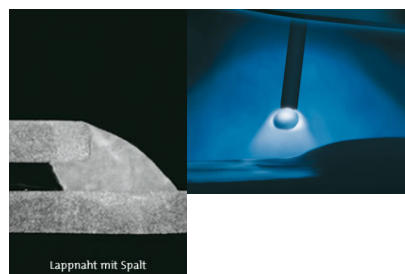
“By using a negative phase, targeted heat-placing control is possible during the Cold Weld process which allows a very low heat input”

- ✓ optimum control of the welding process
- ✓ high weld seam quality
- ✓ good gap bridging ability
- ✓ increased weld speed
- ✓ minimized component distortion

Vari Drive function

ignition control for spatter free welding of coated surfaces

steel, high-strength steel, aluminium, chrome nickel materials, coated plates



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Merkle “Cold MIG”

“the characteristic curve is controlled in the up and down slope cycle by an ultrafast digital signal processor. Also constant frequency of the drop transfer”



Application:

- Welding of thin sheet metals 0.6 – 3.0 mm
- High gap bridging capacity
- MIG brazing at low heat input
- Welding of mixed materials
- Welding of coated sheet metals

Process benefits:

Comparison of heat inputs	Gap bridging capability	MIG brazing of galvanised sheet metals
20-30% less heat input in comparison to conventional short arc welding.	The high gap bridging capability sets new standards even with complex requirements and applications.	MIG brazing of galvanised sheet metals to perfection thanks to 30% less heat input.
heat reduction from ColdMIG		

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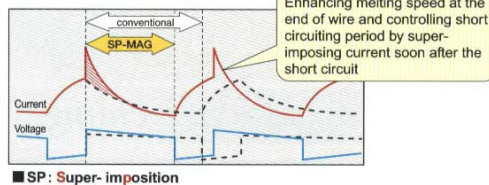
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Panasonic “SP MAG”

- Ultra low spatter levels
- Low heat input
- Low susceptibility to arc blow
- Wide process windows across entire amperage range
- Excellent thin material and gap handling capability

● Compared with current model :

1/5~1/7 in SP-MAG welding
1/2 in CO2 welding



● Secondary switching control

reduces spatter generation by detecting the status of arc (short circuit / open) precisely.



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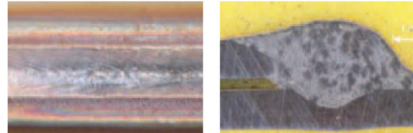
SKS microMIG™

low heat input robotic welding

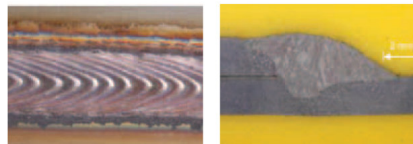
(SKS Welding systems and Motoman Robotics)

"a patented process for controlling droplet detachment - the system is designed to be used in combination with the Frontpull Weld Package and advanced robot welding equipment such as synchroweld "

- ✓ spatter free material transfer
- ✓ excellent weld appearance
- ✓ substantially reduced distortion
- ✓ minimum investment, existing weld facilities can be updated quickly (standard SKS components)
- ✓ welding of thin plates (0.5mm)



A weld seam and a micrograph of lap joint in 0,8 mm CrNi-steel robot welded at 100 cm/min using the microMIG process. Wire: ER 307 Si 1,0 mm. Gas: 98% Ar 2% CO₂.



A weld seam and a micrograph of lap joint in 2,0 mm CrNi-steel robot welded at 100 cm/min using the microMIG process. Wire: ER 430 CB 1,0 mm. Gas: 98% Ar 2% CO₂.

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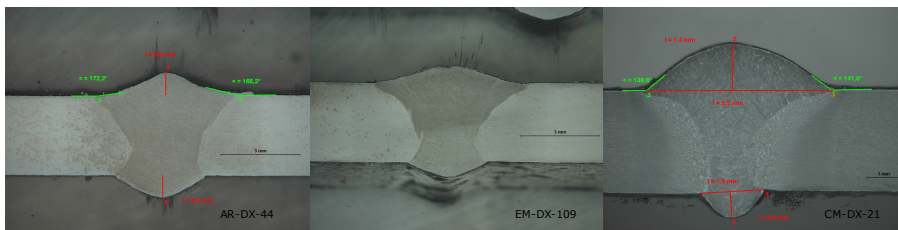
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Butt joints 3 mm (12.50 & Mison18)

Aristo, 100 cm/m

EWM, 100 cm/m
coldArc

CMT, 100 cm/m



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Conclusions from ongoing work

- ❑ Cold processes (CMT and coldArc) show potential for spatter free welding - also for coated materials.
- ❑ Tolerances are important
 - varying gap distance may result in process instabilities.
- ❑ Cold processes have limited potential for $\geq 3\text{mm}$ gauge. Lack of fusion may become an issue and also productivity is low.
- ❑ Root pass welding without backing may be facilitated.
- ❑ Low heat input during MIG brazing have shown to decrease occurrence of weld cracking (base metal and weld).
- ❑ Low heat input welding is beneficial for mixed material welding, specific filler materials can be used (i.e. Zn wires for Al+Fe)
- ❑ Monitoring of the CMT process revealed similarities to pulsed processes, i.e. did not show features as described by supplier.
- ❑ CMT is very user friendly
 - although with limited possibilities for advanced optimization.

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Future trends

- ❑ Even colder welding
 - trend towards thinner gauge and increased use of mixed materials
- ❑ Increased process robustness and flexibility
 - mechanised processes requires gap bridging capability
 - trend towards increased use of dissimilar gauge
- ❑ "Multi-use" power sources,
 - built in capacity for various needs, i.e. both cold welding and high productivity welding
- ❑ Highly specialized power sources,
 - i.e. adopted for specific applications

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Interesting new concepts

- ❑ Fronius launches "CMT Advanced"
and claim "ice cold welding",
also state increased capabilities for varying gap distances
- ❑ OTC Daihen has developed a system
with integrated robot and AC MIG power source,
developed for Japanese automotive demands
– varying gap distances and thin-thick gauge combinations
in focus

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The new CMT Advanced technology A revolution in ice-cold welding and gap bridging

showed at the Essen Exhibition
Market launch Q3 2010



Fronius

Product Launch 2009

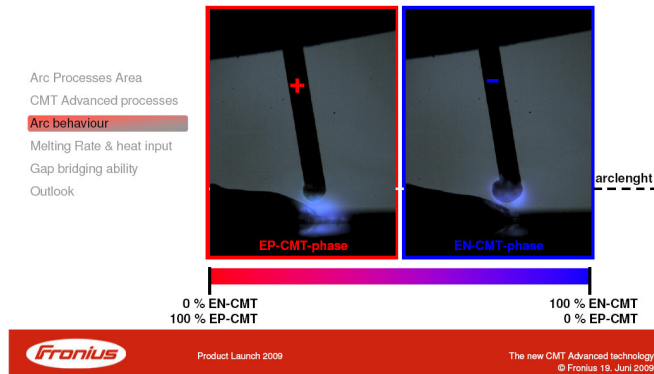
The new CMT Advanced technology
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III. The arc behaviour

Influence of the electrode polarity on the arc behaviour

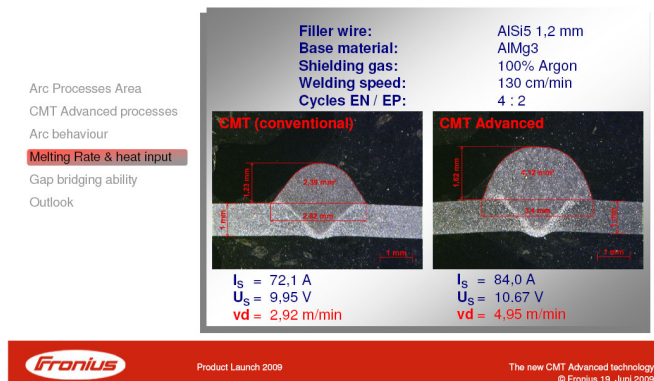


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IV. The melting rate and heat input

Comparison melting rate CMT / CMT Advanced



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V. The gap bridging ability

What means practically factual gap bridging?

Arc Processes Area

CMT Advanced processes

Arc behaviour

Melting Rate & heat input

Gap bridging ability

Outlook

Process: CMT-Pulse Advanced
Filler wire: AISi5 1,2 mm
Base material: AlMg3
Shielding gas: 100
speed: 60
EN / EP: 14



$I_s = 100\text{ A}$
 $U_s = 11,6\text{ V}$
 $vd = 6,7\text{ m/min}$

→ It is possible weld both – maximum gap and zero gap with the same parameter adjustment



Product Launch 2009

The new CMT Advanced technology
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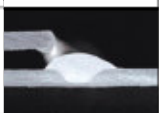
OTC Daihen AC-MIG

synergic AC pulse arc control
DW300

“ By utilizing special AC waveforms that allow adjustment of the electrode negative (EN) half cycle, the DW300 is capable of controlling the heat input”

- ✓ reduces heat input 30-40%
- ✓ greatly reduced heat distortion
- ✓ incredible gap bridging technology
- ✓ taught weaving function (robot) for welding of thin-to-thick material
- ✓ can switch between AC and DC on-the-fly for materials that vary in thickness
- ✓ automatic compensation of process parameters and robot motion with varying joint tolerances



EN Ratio	Cross Section
0%	
10%	
20%	

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