

# Arc sensing in Cold Metal Transfer Arc Welding Process - For Seam Tracking and Height Control in Automated CMT Arc Welding

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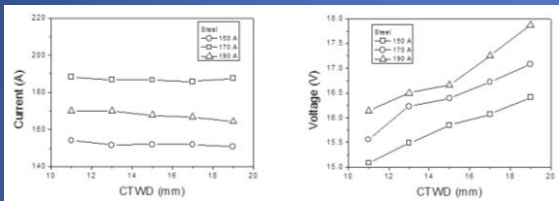


## Motivation

Cold metal transfer (CMT) arc welding has been recently proposed as a special gas metal arc (GMA) welding process specialized on dip transfer welding. During the short circuiting of the filler wire and the base metal, the filler wire retreating in the backward direction helps reigniting of welding arc and stabilizes metal transfer without spatter generation. The conventional arc sensing technology by sensing the welding current waveform is no longer available for CMT arc welding because CMT process is based upon controlled wire feeding and optimized pulse current waveform, whereas the conventional GMA welding system operates at the constant voltage mode with constant wire feed speed.

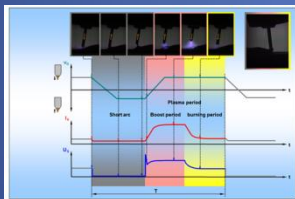
## Height detection

For Fixed Contact tip-to-workpiece distance(CTWD): Averaged signals for 5 s

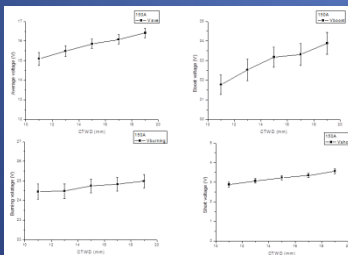


Linear relationship between CTWD and welding current for welding steel

## Characterization of waveform



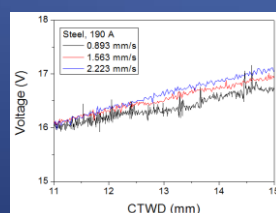
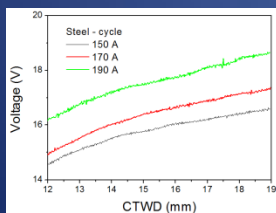
- Average per cycle
- Signal during the boost mode
- Signal during the burning mode
- Signal during the short mode



Similar relationships except burning mode signals

## For gradual increase of CTWD:

- Average voltage per cycle
- 10 points moving average
- With various welding currents
- Average voltage per cycle
- 10 points moving average
- With various CTWD increase rates

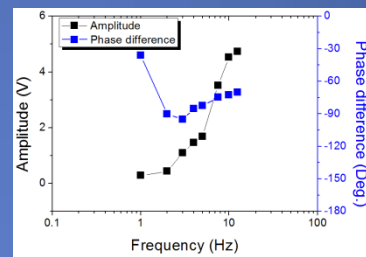
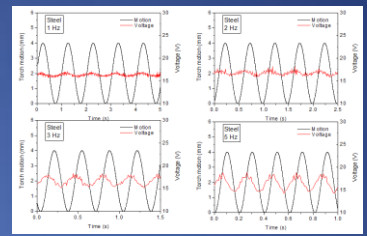
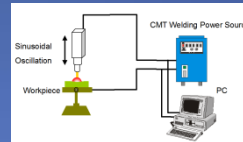


## Dynamic characteristics

### Frequency domain analysis

High frequency oscillation  
= 2 \* 20 = 4 (sin/cos)  
- Reference CTWD, 20 = 18

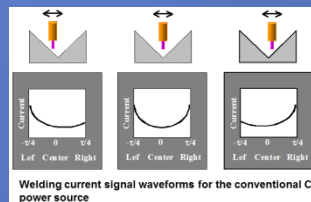
Material	Current (A)	Voltage (V)	Welding Speed (mm/s)	Amplitude (mm)	Frequency (Hz)
Steel	171	14	0.5	2	1-10



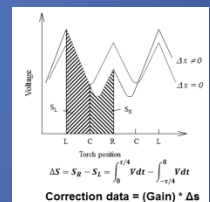
Phase difference should be considered in designing arc sensor

## Seam tracking for weaving welding

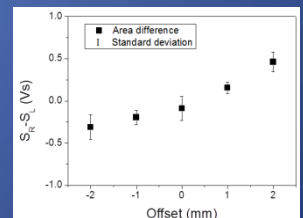
### Principle of seam tracking by using arc sensor



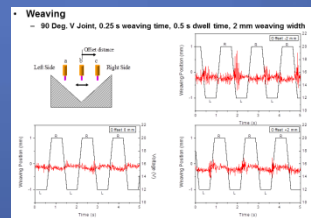
Welding current signal waveforms for the conventional CV power source



### Offset distance vs. area difference



### Signals



## CONCLUSION

The CMT process is based upon not constant voltage control but constant current control. By analyzing the welding signals, it was revealed that the CTWD correlates with the welding voltage to a certain degree. To stabilize torch height prediction, proper signal conditioning as like moving average can be considered. In high frequency oscillation, there is severe phase difference between the voltage signal and motion. The phase difference should be compensated for seam tracking, especially in high frequency weaving cases. Nevertheless, the joint seam sensing using an arc sensor seems to be feasible.