# FOUNDRY-MASTER Smart 2

## Application Note – Calibration Ranges

HITACHI

Precision made practical. Confidence in every spark.

**Background**

The FOUNDRY-MASTER Smart 2 is a stationary spark spectrometer designed to deliver precise, repeatable, and stable results for routine metal analysis in foundries and manufacturing environments. It is the ideal solution for the metal production and processing industry, providing cost-effective, reliable analysis. This new generation optical emission spectrometer offers high analytical performance at an extremely compact size for seamless quality control in metal production and processing at multiple stages of the process.

Upgraded with CMOS sensor technology, an ultra-stable spark source and improved calibrations covering ten material bases, the FOUNDRY-MASTER Smart 2 ensures excellent repeatability and extended application coverage across ferrous and non-ferrous alloys.

The compact housing and robust construction allow continuous use in demanding industrial conditions.

With the intuitive operating software SpArcfire, straightforward calibration routines, and low maintenance requirements, the FOUNDRY-MASTER Smart 2 provides dependable performance for QA/QC, PMI, and secondary metal production – combining high analytical quality with proven ease of use.

### Key Features

- Analyses the majority of metals and their alloys
- High analytical performance from powerful optics
- Scientific CMOS sensor technology for improved precision
- Ultra-stable spark source for consistent long-term stability
- Wavelength range: 172 – 420 nm
- Very short start-up and measurement time
- Identification of duplex steels with nitrogen analysis
- Compact footprint of just 415 × 665 mm and 35 kg – easy to handle
- Robust housing and design for continuous use in industrial environments
- Preinstalled GRADE Database for fast and easy grade identification
- Results at your fingertips: wide range of result forms, automatic storage
- Excellent price-performance ratio

****Disclaimer****

The calibration ranges and analytical parameters shown in this document reflect the current development status of the FOUNDRY-MASTER Smart 2. They are not final and may be subject to change as validation and further optimization are completed. Some details regarding element coverage, limits of detection, and precision values may therefore differ in the final release.

## Sample preparation

Correct sample preparation is very important for precise and accurate OES results. A flat sample surface is essential. To achieve this, different techniques, like grinding or milling, are appropriate, depending on the material and the elements to be analysed.

**Sample preparation for Al, Cu, Mg, Pb, Sn, Ti, Zn**

Our recommendation is to use a milling machine equipped with indexable inserts specified for copper alloys. The machine should be optimised for each Cu alloy.

Alternatively, you can use a turning lathe.
For the results presented in this application note, all copper alloys were milled.

**Sample preparation for Co, Fe, Ni**

If low Al concentrations need to be measured, aluminum oxide is typically used, depending on the analyte material. Zirconium oxide or silicon carbide are alternatives, grain size 40 – 80.

Cast iron samples are typically prepared with grindstones or cup wheels (stone with segments) while steel is typically prepared with disc or belt grinding machines.

In this case, in order to perform sets of precession measurements, all samples were carefully and appropriately ground on a stationary disk grinder with mesh size 60 Al-corundum paper.

## Difference between LOD and LOQ

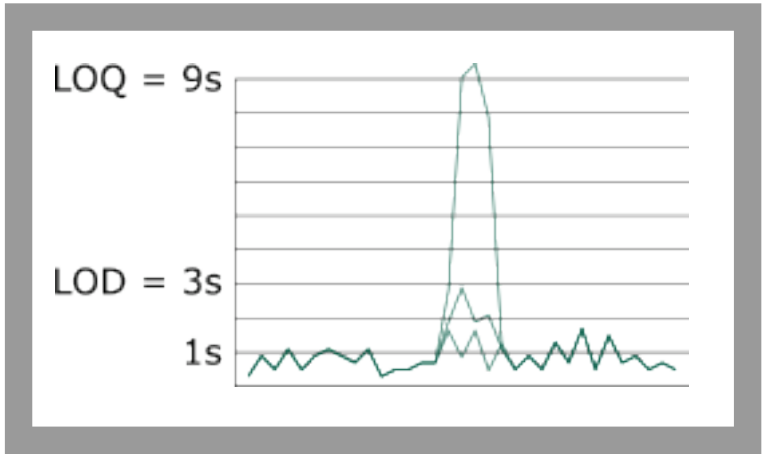
The BEC (equivalent concentration of spectral background) value is the concentration of the analysis sample required to produce the same intensity signal as the background at a given wavelength. The BEC is obtained from the calibration curve and is a fundamental process variable as it directly affects the LOD (**limit of detection**). The LOD is the smallest amount of an element detectable, and it is calculated as follows:

$$LOD = \frac{3}{100} RSD_0 \times BEC$$

$RSD_0$ is correlated to the relative standard value of spectral background. With the BEC value calculated from the calibration curve, we are able to detect different elements in the matrix down to the level of precision (1δ).

However, the **lowest quantitatively determinable amount** (Limit of Quantitation or LOQ) must be larger than the spectrometric LOD by a multiple of three. The resulting LOQ is the quantitatively readable value with our instrument.

The following tables show the calibration ranges of the FOUNDRY-MASTER Smart 2



# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Fe base

Min and Max in wt%

| | Fe_000 | | Fe_100 | | Fe_200 | | Fe_250 | | Fe_300 | | Fe_400 | | Fe_500 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Orientation | | Low alloy | | Cast steel | | Cr hard & Ni resist | | Stainless steel | | Tool steel | | Mn steel | |
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| Al | 0.0030 | 6 | 0.0010 | 1.5 | 0.0010 | 0.28 | 0.0010 | 0.28 | 0.0020 | 6 | 0.0015 | 0.01 | 0.0020 | 0.3 |
| As | | | 0.0010 | 0.2 | 0.0010 | 0.2 | | | | | | | | |
| B | 0.0005 | 1.8 | 0.0005 | 0.07 | 0.0005 | 0.1 | 0.0010 | 0.1 | 0.0005 | 0.015 | | | | |
| Bi | | | 0.0050 | 0.12 | 0.0030 | 0.015 | | | | | | | | |
| C | 0.0025 | 4 | 0.0020 | 1.6 | 1.5000 | 5 | 1.0000 | 3.8 | 0.0030 | 1.5 | 0.0060 | 2.75 | 0.0040 | 1.8 |
| Ca | | | 0.0001 | 0.015 | | | | | 0.0005 | 0.015 | | | | |
| Ce | | | | | 0.0050 | 0.1 | | | | | | | | |
| Co | 0.0010 | 10 | 0.0010 | 0.55 | 0.0020 | 0.25 | 0.0010 | 0.6 | 0.0010 | 12.5 | 0.0010 | 13 | 0.0010 | 0.6 |
| Cr | 0.0030 | 35 | 0.0005 | 5.5 | 0.0020 | 3 | 0.0015 | 37.5 | 0.0020 | 35. | 0.0015 | 21.5 | 0.0010 | 4.2 |
| Cu | 0.0020 | 9 | 0.0005 | 1 | 0.0010 | 3 | 0.0010 | 10 | 0.0010 | 8.5 | 0.0010 | 0.25 | 0.0010 | 0.8 |
| La | | | | | 0.0005 | 0.03 | | | | | | | | |
| Mg | 0.0005 | 0.1 | | | 0.0002 | 0.2 | 0.0005 | 0.2 | | | | | | |
| Mn | 0.0020 | 20 | 0.0010 | 2.5 | 0.0010 | 2.5 | 0.0010 | 2 | 0.0010 | 13.5 | 0.0015 | 2 | 5.0000 | 25 |
| Mo | 0.0050 | 10 | 0.0010 | 1.5 | 0.0020 | 1.7 | 0.0020 | 4 | 0.0010 | 7 | 0.0025 | 10.5 | 0.0015 | 2.2 |
| N | | | | | | | | | 0.0500 | 1.2 | | | | |
| Nb | 0.0025 | 2 | 0.0010 | 1.6 | 0.0010 | 0.17 | 0.0010 | 0.75 | 0.0040 | 3.3 | 0.0015 | 1.7 | 0.0010 | 0.35 |
| Ni | 0.0030 | 55 | 0.0030 | 5.5 | 0.0010 | 5 | 0.0050 | 28.5 | 0.0020 | 55 | 0.0010 | 3.5 | 0.0020 | 4.5 |
| P | | | 0.0025 | 0.12 | 0.0005 | 1.5 | 0.0010 | 0.73 | 0.0010 | 0.15 | 0.0005 | 0.35 | 0.0020 | 0.12 |
| Pb | | | 0.0030 | 0.15 | 0.0040 | 0.13 | | | 0.0080 | 0.3 | | | | |
| S | | | 0.0010 | 0.1 | 0.0020 | 0.3 | 0.0020 | 0.2 | 0.0020 | 0.1 | 0.0020 | 0.09 | 0.0020 | 0.3 |
| Sb | | | 0.0025 | 0.15 | 0.0020 | 0.27 | | | 0.0030 | 0.15 | | | | |
| Se | | | 0.0025 | 0.4 | 0.0025 | 0.03 | | | 0.0030 | 0.4 | | | | |
| Si | 0.0020 | 10 | 0.0010 | 2.4 | 0.0010 | 6.7 | 0.0020 | 6.5 | 0.0010 | 4 | 0.0010 | 1.3 | 0.0020 | 2.5 |
| Sn | | | 0.0010 | 0.25 | 0.0010 | 0.22 | 0.0010 | 0.25 | 0.0010 | 0.3 | 0.0010 | 0.32 | 0.0010 | 0.075 |
| Ti | 0.0020 | 2 | 0.0005 | 0.5 | 0.0010 | 0.26 | 0.0010 | 0.27 | 0.0010 | 2.5 | 0.0005 | 0.5 | 0.0010 | 1.2 |
| V | 0.0020 | 10 | 0.0010 | 0.8 | 0.0010 | 0.75 | 0.0010 | 0.75 | 0.0010 | 1. | 0.0010 | 10.5 | 0.0010 | 0.15 |
| W | 0.0050 | 20 | 0.0010 | 1.8 | 0.0050 | 0.2 | 0.0050 | 0.6 | 0.0070 | 3.5 | 0.0020 | 22.5 | | |
| Zn | | | 0.0005 | 0.025 | 0.0010 | 0.044 | | | | | | | | |
| Zr | | | 0.0015 | 0.4 | 0.0015 | 0.05 | | | 0.0015 | 0.4 | | | | |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Al base

Min and Max in wt%

| | AL_000 | | AL_100 | | AL_200 | | AL_300 | | AL_400 | | AL_450 | | AL_500 | | AL_550 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Al-orientation | | Al-low alloy | | Al-Cu alloy | | Al-Mg alloy | | Al-Si alloy | | Al-Si-Cu alloy | | Al-Zn alloy | | Al-Zn-Si alloy | |
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| Ag | 0.005 | 1.2 | 0.0005 | 1.2 | 0.0005 | 1.2 | 0.0005 | 1.2 | 0.0005 | 1.2 | 0.0005 | 1.2 | 0.0005 | 1.2 | 0.0005 | 1.2 |
| B | | | 0.0005 | 0.025 | 0.0005 | 0.025 | 0.0005 | 0.025 | 0.0005 | 0.025 | 0.0005 | 0.025 | 0.0005 | 0.025 | 0.0005 | 0.025 |
| Be | | | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 |
| Bi | | | 0.0030 | 0.7 | 0.0030 | 0.7 | 0.0030 | 0.7 | 0.0030 | 0.7 | 0.0030 | 0.7 | 0.0030 | 0.7 | 0.0030 | 0.7 |
| Ca | | | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.025 | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 | 0.0001 | 0.02 |
| Cd | | | 0.0005 | 0.34 | 0.0005 | 0.34 | 0.0005 | 0.34 | 0.0005 | 0.34 | 0.0005 | 0.34 | 0.0005 | 0.34 | 0.0005 | 0.34 |
| Ce | | | 0.0010 | 0.06 | 0.0010 | 0.06 | 0.0010 | 0.1 | 0.0010 | 0.06 | 0.0010 | 0.06 | 0.0010 | 0.06 | 0.0010 | 0.06 |
| Co | 0.005 | 0.5 | 0.0010 | 0.5 | 0.0015 | 0.5 | 0.0010 | 0.5 | 0.0010 | 0.5 | 0.0010 | 0.5 | 0.0010 | 0.5 | 0.0010 | 0.5 |
| Cr | 0.005 | 0.7 | 0.0005 | 0.6 | 0.0010 | 0.6 | 0.0005 | 0.7 | 0.0005 | 0.6 | 0.0005 | 0.55 | 0.0005 | 0.7 | 0.0005 | 0.7 |
| Cu | 0.010 | 10 | 0.0020 | 0.8 | 0.0015 | 10 | 0.0020 | 5.5 | 0.0020 | 4 | 0.0020 | 10 | 0.0020 | 4 | 0.0020 | 4 |
| Fe | 0.005 | 2.8 | 0.0015 | 2.2 | 0.0010 | 2.8 | 0.0015 | 2.2 | 0.0015 | 2.2 | 0.0015 | 2.2 | 0.0015 | 2.2 | 0.0015 | 2.2 |
| Ga | | | 0.0005 | 0.12 | 0.0005 | 0.12 | 0.0005 | 0.15 | 0.0005 | 0.12 | 0.0005 | 0.15 | 0.0005 | 0.15 | 0.0005 | 0.15 |
| Hg | | | 0.0020 | 0.075 | 0.0100 | 0.075 | 0.0100 | 0.08 | 0.0020 | 0.075 | 0.0020 | 0.075 | 0.0020 | 0.075 | 0.0020 | 0.075 |
| In | | | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 |
| La | | | 0.0005 | 0.04 | 0.0005 | 0.1 | 0.0005 | 0.1 | 0.0005 | 0.05 | 0.0005 | 0.04 | 0.0005 | 0.04 | 0.0005 | 0.04 |
| Li | | | 0.0002 | 0.025 | 0.0002 | 0.025 | 0.0002 | 0.025 | 0.0002 | 0.025 | 0.0002 | 0.025 | 0.0002 | 0.025 | 0.0002 | 0.025 |
| Mg | 0.005 | 12 | 0.0010 | 1.5 | 0.0005 | 1.5 | 0.0001 | 12 | 0.0005 | 3 | 0.0010 | 3 | 0.0010 | 4 | 0.0010 | 4 |
| Mn | 0.005 | 2.2 | 0.0005 | 2.2 | 0.0005 | 2.2 | 0.0005 | 2.2 | 0.0005 | 2.2 | 0.0005 | 2.2 | 0.0015 | 2.2 | 0.0015 | 2.2 |
| Mo | 0.005 | 1 | 0.0005 | 1 | 0.0010 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 |
| Na | | | 0.0002 | 0.015 | 0.0002 | 0.015 | 0.0002 | 0.015 | 0.0002 | 0.015 | 0.0002 | 0.015 | 0.0002 | 0.015 | 0.0002 | 0.015 |
| Ni | 0.005 | 6 | 0.0010 | 2.2 | 0.0010 | 5.5 | 0.0010 | 5.5 | 0.0010 | 6 | 0.0010 | 5.5 | 0.0010 | 6 | 0.0010 | 6 |
| P | | | 0.0035 | 0.018 | 0.0040 | 0.018 | 0.0025 | 0.018 | 0.0030 | 0.018 | 0.0030 | 0.018 | 0.0035 | 0.018 | 0.0035 | 0.018 |
| Pb | | | 0.0010 | 1.6 | 0.0010 | 1.6 | 0.0010 | 1.8 | 0.0010 | 1.6 | 0.0010 | 1.6 | 0.0010 | 1.6 | 0.0010 | 1.6 |
| Sb | | | 0.0050 | 0.6 | 0.0080 | 0.6 | 0.0063 | 0.6 | 0.0075 | 0.6 | 0.0075 | 0.6 | 0.0050 | 0.6 | 0.0050 | 0.6 |
| Sc | | | 0.0005 | 0.85 | 0.0005 | 0.85 | 0.0010 | 0.85 | 0.0005 | 0.85 | 0.0005 | 0.85 | 0.0005 | 0.9 | 0.0005 | 0.9 |
| Si | 0.005 | 25 | 0.0015 | 1.5 | 0.0020 | 1.7 | 0.0010 | 1.35 | 0.0010 | 25 | 0.0015 | 25. | 0.0015 | 1.8 | 0.0015 | 25 |
| Sn | 0.005 | 4 | 0.0020 | 1.2 | 0.0020 | 4 | 0.0050 | 4 | 0.0035 | 4 | 0.0020 | 4 | 0.0020 | 4 | 0.0020 | 4 |
| Sr | | | 0.0001 | 0.15 | 0.0001 | 0.16 | 0.0001 | 0.15 | 0.0001 | 0.15 | 0.0001 | 0.15 | 0.0001 | 0.15 | 0.0001 | 0.15 |
| Ti | | | 0.0005 | 0.65 | 0.0005 | 0.65 | 0.0005 | 0.65 | 0.0005 | 0.65 | 0.0005 | 0.65 | 0.0005 | 0.7 | 0.0005 | 0.7 |
| V | | | 0.0010 | 0.15 | 0.0010 | 0.12 | 0.0010 | 0.65 | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 | 0.0010 | 0.12 |
| Zn | 0.005 | 12.5 | 0.0015 | 2.2 | 0.0020 | 2.2 | 0.0015 | 5 | 0.0020 | 2.2 | 0.0015 | 2 | 0.0020 | 12.5 | 0.0020 | 12.5 |
| Zr | | | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 | 0.0005 | 1 |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Cu base

Min and Max in wt%

| | Cu_000 | | Cu_100 | | Cu_200 | | Cu_300 | | Cu_350 | | Cu_400 | | Cu_450 | | Cu_500 | | Cu_600 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Global | | low alloy copper | | Cu-Zn brass | | Cu-Sn-Pb bronze | | Gunmetal | | Cu-Ni alloy | | Cu-Ni-Zn alloy | | Cu-Al alloy | | Be/Co/Ag alloy | |
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| Ag | 0.0015 | 1.1 | 0.0015 | 0.5 | 0.0015 | 0.5 | 0.0015 | 1 | 0.0015 | 1 | | | 0.0015 | 0.12 | | | 0.0015 | 1 |
| Al | 0.0020 | 12 | 0.0010 | 1 | 0.0020 | 8 | 0.0010 | 4 | 0.0010 | 0.5 | 0.0010 | 1.6 | 0.0015 | 0.3 | 2.0000 | 12 | 0.0010 | 0.2 |
| As | | | 0.0010 | 0.5 | 0.0010 | 0.5 | 0.0010 | 1.8 | 0.0010 | 0.55 | | | | | 0.0015 | 0.3 | | |
| B | | | 0.0015 | 0.04 | | | | | | | 0.0015 | 0.04 | | | | | | |
| Be | 0.0010 | 2 | 0.0002 | 0.6 | | | | | | | 0.0001 | 0.18 | | | | | 0.0002 | 2.2 |
| Bi | | | 0.0015 | 0.5 | 0.0015 | 6 | 0.0020 | 6 | 0.0015 | 1 | 0.0010 | 0.4 | | | | | | |
| Cd | | | 0.0005 | 1 | 0.0005 | 0.6 | 0.0015 | 0.2 | 0.0015 | 0.5 | | | | | | | | |
| Co | 0.0020 | 3.3 | 0.0020 | 1 | 0.0020 | 0.5 | 0.0015 | 0.5 | 0.0020 | 0.25 | 0.0015 | 0.2 | 0.0015 | 0.25 | | | 0.0010 | 3.3 |
| Cr | 0.0010 | 3 | 0.0010 | 1 | 0.0010 | 0.1 | 0.0015 | 0.1 | 0.0015 | 0.1 | 0.0010 | 3 | | | | | 0.0010 | 0.1 |
| Fe | 0.0030 | 6.7 | 0.0020 | 1 | 0.0020 | 2 | 0.0020 | 2.4 | 0.0020 | 1 | 0.0015 | 3 | 0.0020 | 0.5 | 0.1000 | 6.7 | 0.0020 | 0.2 |
| Mg | | | 0.0005 | 0.2 | | | | | | | 0.0001 | 0.1 | | | 0.0001 | 0.2 | | |
| Mn | | | 0.0005 | 2 | 0.0015 | 20 | 0.0020 | 4 | 0.0015 | 0.6 | 0.0015 | 4.5 | 0.0015 | 0.7 | 0.0015 | 7 | 0.0015 | 0.2 |
| Nb | | | | | | | | | | | 0.0020 | 0.8 | | | | | | |
| Ni | 0.0030 | 36 | 0.0015 | 1 | 0.0015 | 5 | 0.0015 | 3 | 0.0015 | 2.2 | 5.0000 | 36 | 5.0000 | 20 | 0.0015 | 8 | 0.0025 | 0.5 |
| P | | | 0.0015 | 0.2 | 0.0020 | 0.5 | 0.0010 | 1.0 | 0.0015 | 0.3 | 0.0015 | 0.1 | 0.0015 | 0.15 | | | 0.0015 | 0.1 |
| Pb | 0.0015 | 22 | 0.0015 | 1 | 0.0020 | 5 | 0.0015 | 23 | 0.0015 | 10 | 0.0010 | 0.5 | 0.0015 | 1.2 | 0.0015 | 0.5 | 0.0015 | 0.25 |
| S | | | 0.0010 | 0.2 | 0.0010 | 0.2 | 0.0010 | 0.2 | 0.0010 | 0.2 | 0.0015 | 0.15 | 0.0015 | 0.1 | 0.0010 | 0.2 | | |
| Sb | | | 0.0020 | 0.5 | 0.0050 | 0.5 | 0.0020 | 4.5 | 0.0030 | 1.2 | | | | | | | | |
| Se | | | 0.0010 | 0.1 | 0.0015 | 0.5 | 0.0020 | 1 | | | | | | | | | | |
| Si | 0.0020 | 7.8 | 0.0020 | 2.2 | 0.0020 | 4 | 0.0020 | 7.5 | 0.0020 | 0.5 | 0.0015 | 2 | 0.0015 | 1 | 0.0020 | 1 | 0.0020 | 1 |
| Sn | 0.0015 | 18.5 | 0.0015 | 1 | 0.0015 | 10 | 0.0015 | 18.5 | 0.0015 | 11 | 0.0015 | 0.5 | 0.0015 | 0.5 | 0.0015 | 1 | 0.0015 | 0.2 |
| Te | | | 0.0040 | 0.5 | | | | | | | | | | | | | | |
| Ti | | | | | | | | | | | 0.0010 | 0.075 | | | | | | |
| Zn | 0.0040 | 50 | 0.0020 | 1 | 0.0030 | 50 | 0.0050 | 12 | 0.0020 | 14 | 0.0030 | 1.5 | 10.0000 | 40 | 0.0040 | 1 | 0.0020 | 0.25 |
| Zr | | | 0.0005 | 0.1 | | | | | | | 0.0010 | 0.1 | | | | | | |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Ni base

Min and Max in wt%

| | Ni_000 Global | | Ni_100 Low Alloy | | Ni_200 Monel | | Ni_300 Nimonic/Waspalloy | | Ni_400 Incoloy | | Ni_500 Inconel | | Ni_600 Hastelloy | | Ni_700 MarMalloy | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| Al | 0.0005 | 8.5 | 0.0020 | 1 | 0.0010 | 4.5 | 0.0030 | 8 | 0.0003 | 0.5 | 0.0010 | 8 | 0.0005 | 8 | 1.0000 | 8 |
| B | | | 0.0001 | 0.03 | | | 0.0010 | 0.25 | 0.0003 | 0.5 | 0.0003 | 0.5 | 0.0005 | 0.5 | 0.0005 | 0.5 |
| C | | | 0.0050 | 0.5 | 0.0050 | 0.5 | 0.0020 | 0.5 | 0.0020 | 0.5 | 0.0010 | 0.5 | 0.0100 | 0.5 | 0.0100 | 0.5 |
| Co | 0.0100 | 30 | 0.0010 | 1 | 0.0030 | 2 | 0.0005 | 30 | 0.0005 | 5 | 0.0010 | 30 | 0.0005 | 30 | 2.0000 | 15 |
| Cr | 0.0010 | 35 | 0.0020 | 0.9 | 0.0020 | 1 | 10.0000 | 24 | 15.0000 | 25 | 10.0000 | 30 | 0.0005 | 25 | 4.0000 | 30 |
| Cu | 0.0020 | 38 | 0.0002 | 1 | 22.0000 | 38. | 0.0005 | 1 | 0.0010 | 4 | 0.0005 | 3 | 0.0010 | 2 | 0.0010 | 2.5 |
| Fe | 0.0005 | 55 | 0.0010 | 1 | 0.0005 | 3 | 0.0005 | 35 | 1.0000 | 47 | 0.0005 | 40 | 0.0010 | 25 | 0.0010 | 5 |
| Hf | 0.0030 | 2.3 | | | | | | | | | | | | | 0.0050 | 2.3 |
| Mg | | | 0.0001 | 0.15 | 0.0005 | 0.25 | 0.0001 | 0.2 | 0.0010 | 0.25 | 0.0001 | 0.25 | 0.0001 | 0.2 | 0.0001 | 0.25 |
| Mn | 0.0100 | 3.3 | 0.0010 | 1 | 0.0005 | 3.3 | 0.0050 | 1 | 0.0100 | 2 | 0.0050 | 2 | 0.0100 | 2 | 0.0005 | 1 |
| Mo | 0.0010 | 40 | | | | | 0.0050 | 20 | 0.0500 | 10 | 0.0010 | 12 | 0.0050 | 35. | 0.0006 | 4 |
| Nb | 0.0100 | 8.5 | 0.0030 | 1 | | | 0.0010 | 8 | | | 0.0050 | 8 | 0.0100 | 5 | 0.0050 | 2 |
| P | | | 0.0002 | 0.065 | 0.0020 | 0.065 | | | | | | | | | | |
| Pb | | | | | 0.0020 | 0.1 | | | | | | | | | | |
| S | | | 0.0002 | 0.15 | 0.0005 | 0.15 | 0.0010 | 0.15 | 0.0011 | 0.15 | 0.0010 | 0.15 | 0.0010 | 0.15 | 0.0010 | 0.15 |
| Si | 0.0005 | 7.8 | 0.0010 | 0.6 | 0.0010 | 7 | 0.0010 | 3 | 0.0010 | 7.8 | 0.0005 | 1.5 | 0.0100 | 2 | 0.0010 | 8 |
| Sn | | | | | | | 0.0010 | 0.8 | 0.0005 | 1 | 0.0025 | 0.8 | 0.0010 | 0.8 | 0.0020 | 0.8 |
| Ta | 0.0100 | 7.8 | | | | | | | | | | | | | 0.0100 | 7.8 |
| Ti | 0.0010 | 6.5 | 0.0010 | 1 | 0.0005 | 2 | 0.0005 | 6 | 0.0010 | 6 | 0.0005 | 6 | 0.0010 | 5 | 0.0010 | 5 |
| V | | | | | 0.0020 | 0.5 | 0.0010 | 1.2 | | | 0.0010 | 1.2 | 0.0010 | 1 | 0.0050 | 1.2 |
| W | 0.0300 | 13.5 | | | | | 0.0050 | 11.5 | | | 0.0150 | 5 | 0.0150 | 7 | 0.0100 | 13.5 |
| Zr | | | | | | | 0.0010 | 0.3 | | | 0.0010 | 0.3 | 0.0005 | 0.3 | 0.0010 | 0.3 |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Co base

Min and Max in wt%

| | Co_000 | |
|---|---|---|
| | Global | |
| | Min | Max |
| Al | 0.003 | 1.6 |
| B | 0.003 | 0.2 |
| C | 0.003 | 2.8 |
| Cr | 5.000 | 36 |
| Cu | 0.002 | 0.2 |
| Fe | 0.005 | 21 |
| Mn | 0.005 | 2.1 |
| Mo | 0.003 | 8.7 |
| Nb | 0.005 | 2.8 |
| Ni | 0.010 | 26 |
| P | 0.003 | 0.05 |
| Pb | 0.006 | 0.045 |
| S | 0.003 | 0.07 |
| Si | 0.005 | 1.8 |
| Sn | 0.002 | 0.15 |
| Ta | 0.005 | 4.2 |
| Ti | 0.002 | 0.5 |
| W | 0.005 | 17 |
| Zr | 0.003 | 0.5 |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Mg base

Min and Max in wt%

| | Mg_000 | |
|---|---|---|
| | Global | |
| | Min | Max |
| Ag | 0.0010 | 3 |
| Al | 0.0050 | 13.8 |
| Be | 0.0001 | 0.004 |
| Ca | 0.0005 | 0.7 |
| Cd | 0.0005 | 0.08 |
| Ce | 0.0050 | 2.3 |
| Cu | 0.0020 | 3.2 |
| Er | 0.0005 | 0.25 |
| Fe | 0.0050 | 0.04 |
| Gd | 0.0030 | 2.3 |
| La | 0.0020 | 1.5 |
| Mn | 0.0005 | 2.5 |
| Nd | 0.0090 | 3.5 |
| Ni | 0.0025 | 0.06 |
| Pb | 0.0050 | 0.1 |
| Pr | 0.0050 | 0.9 |
| Si | 0.0200 | 2 |
| Sn | 0.0020 | 0.1 |
| Sr | 0.0005 | 1.2 |
| Yb | 0.0010 | 0.15 |
| Zn | 0.0100 | 7 |
| Zr | 0.0010 | 0.6 |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Ti base

Min and Max in wt%

| | Ti_000 | |
|---|---|---|
| | Global | |
| | Min | Max |
| Al | 0.005 | 9.00 |
| C | 0.001 | 0.13 |
| Cr | 0.001 | 7.00 |
| Cu | 0.002 | 3.00 |
| Fe | 0.005 | 2.50 |
| Mn | 0.002 | 7.70 |
| Mo | 0.010 | 5.30 |
| Nb | 0.010 | 7.50 |
| Ni | 0.001 | 1.00 |
| Pd | 0.001 | 0.20 |
| Ru | 0.005 | 0.11 |
| Si | 0.002 | 0.70 |
| Sn | 0.005 | 12.40 |
| Ta | 0.005 | 1.10 |
| V | 0.005 | 16.20 |
| W | 0.010 | 1.10 |
| Zr | 0.005 | 6.00 |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Zn base

Min and Max in wt%

| | Zn_000 | | Zn_100 | | Zn_200 | | Zn_300 | | Zn_400 | | Zn_500 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Orientation | | low alloy | | Zn-Al 2-6% | | Zn-Al 6-15% | | Zn-Al >15% | | Zamak | |
| | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max | Min | Max |
| Al | 0.0010 | 60 | 0.0005 | 1.5 | 1.5000 | 6.2 | 5.5000 | 15.5 | 15.0000 | 60 | 3.0000 | 5 |
| Bi | | | 0.0005 | 0.15 | | | | | | | | |
| Cd | 0.0005 | 0.8 | 0.0005 | 0.8 | 0.0005 | 0.04 | 0.0005 | 0.06 | 0.0005 | 0.1 | 0.0005 | 0.03 |
| Cr | | | 0.0010 | 0.2 | | | | | | | | |
| Cu | 0.0010 | 6.5 | 0.0005 | 1 | 0.0010 | 3.5 | 0.0015 | 6.5 | 0.0020 | 3.5 | 0.0005 | 4 |
| Fe | 0.0050 | 0.7 | 0.0020 | 0.7 | 0.0015 | 0.12 | 0.0015 | 0.5 | 0.0015 | 0.7 | 0.0015 | 0.03 |
| Mg | 0.0001 | 0.25 | | | 0.0001 | 0.25 | 0.0001 | 0.15 | 0.0001 | 0.15 | 0.0001 | 0.1 |
| Mn | 0.0010 | 0.1 | | | 0.0010 | 0.1 | 0.0010 | 0.02 | 0.0005 | 0.015 | | |
| Ni | | | | | 0.0020 | 0.05 | 0.0020 | 0.015 | | | 0.0015 | 0.03 |
| Pb | 0.0010 | 2.5 | 0.0005 | 3 | 0.0010 | 0.05 | 0.0005 | 0.08 | 0.0010 | 2.5 | 0.0005 | 0.03 |
| Sb | | | 0.0025 | 0.4 | | | | | | | | |
| Si | 0.0010 | 0.07 | | | 0.0010 | 0.05 | 0.0005 | 0.07 | 0.0005 | 1.2 | 0.0005 | 0.03 |
| Sn | 0.0010 | 3 | 0.0005 | 3 | 0.0015 | 0.2 | 0.0010 | 0.15 | 0.0010 | 0.02 | 0.0010 | 0.015 |
| Ti | | | | | | | 0.0005 | 0.35 | | | | |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Pb base

Min and Max in wt%

| | Pb_000 | |
|---|---|---|
| | Global | |
| | Min | Max |
| Ag | 0.0005 | 2.5 |
| Al | 0.0005 | 0.6 |
| As | 0.0010 | 1.6 |
| Au | 0.0005 | 0.1 |
| Ca | 0.0005 | 0.27 |
| Cd | 0.0010 | 0.5 |
| Cu | 0.0005 | 0.4 |
| Fe | 0.0010 | 0.02 |
| In | 0.0005 | 0.7 |
| Ni | 0.0005 | 0.02 |
| Sb | 0.0010 | 11 |
| Se | 0.0010 | 0.05 |
| Sn | 0.0010 | 70 |
| Te | 0.0010 | 0.04 |
| Tl | 0.0005 | 0.06 |
| Zn | 0.0005 | 0.5 |

# FOUNDRY-MASTER Smart 2

Sub-programs & calibration range Sn base

Min and Max in wt%

| | Sn_000 | | Sn_200 | |
|---|---|---|---|---|
| | Global | | lead free solder | |
| | Min | Max | Min | Max |
| Ag | 0.0005 | 4.7 | 0.0005 | 4.7 |
| Al | 0.0002 | 0.075 | 0.0002 | 0.075 |
| As | 0.0050 | 0.6 | 0.0050 | 0.6 |
| Au | 0.0005 | 0.125 | 0.0005 | 0.125 |
| Bi | 0.0005 | 55 | 0.0005 | 55 |
| Cd | 0.0005 | 2 | 0.0005 | 0.55 |
| Co | 0.0005 | 0.025 | 0.0005 | 0.025 |
| Cu | 0.0005 | 12 | 0.0005 | 12 |
| Fe | 0.0005 | 0.08 | 0.0005 | 0.08 |
| Ga | 0.0005 | 0.05 | 0.0005 | 0.05 |
| Ge | 0.0050 | 0.5 | | |
| Hg | 0.0010 | 0.17 | | |
| In | 0.0005 | 0.15 | 0.0005 | 0.15 |
| Ni | 0.0005 | 1.4 | 0.0005 | 1.4 |
| P | 0.0020 | 0.035 | 0.0020 | 0.035 |
| Pb | 0.0005 | 40 | 0.0005 | 1 |
| S | 0.0020 | 0.025 | 0.0020 | 0.025 |
| Sb | 0.0005 | 15.5 | 0.0005 | 15.5 |
| Se | 0.0005 | 0.05 | | |
| Te | 0.0005 | 0.08 | | |
| Zn | 0.0005 | 9 | 0.0005 | 9 |

## PERFORMANCE DISCLAIMER

All performance data provided in this document is based on certified reference materials and typical sample conditions (flat ground or milled). The calibration ranges shown represent averaged data across multiple material types and should be considered as indicative "typical" values only. Calibration ranges can be extended upon request using verified customer samples.

Detection limits (DL) have been determined on a production series instrument according to **DIN 32645:2008-11** using a 99.7% confidence interval (3σ method), and reflect ideal conditions with well-prepared, homogeneous reference materials. Please note that these limits may vary depending on the alloy matrix, sample homogeneity, and measurement parameters. **A reported value at or near the detection limit should not be interpreted as definitive evidence of the presence of an element unless the matrix and signal behavior clearly support it.**

Upper and lower concentration ranges are influenced by the availability and suitability of certified or secondary standards. Extensions beyond published values are possible if sufficient suitable standards are available and verified for homogeneity and traceability.

For specific applications or material requirements, we recommend discussing your needs directly with our technical team. We are happy to verify performance with your own samples upon request.

# FOUNDRY-MASTER Smart 2

Application Note – Calibration Ranges

HITACHI

## Summary

Hitachi High-Tech's FOUNDRY-MASTER Smart 2 delivers accurate and repeatable results for a wide range of ferrous and non-ferrous alloys. Its compact footprint, robust design and intuitive operation make it well suited for routine use in foundries and manufacturing environments. The combination of CMOS sensor technology, the proven spark source, and extended calibrations ensures stable performance across multiple applications, from QA/QC to secondary metal production. With results available within seconds and automatic data storage, the FOUNDRY-MASTER Smart 2 supports fast decision-making, improved process control, and reduced production costs.

## Ordering information

The instrument configuration and accessories used to produce the data in this application note are included in the following packages:
FOUNDRY-MASTER Smart 2 with standard calibrations (10 bases) or customer-specific calibration set

**Optional accessories**

- Wire adapter kit (1.5–10 mm diameter)
- Boron nitride sample plate for small parts (≥ 5 mm)
- Additional sample holders and spark stand inserts

## More information

To find out more visit: www.hitachi-hightech.com/hha