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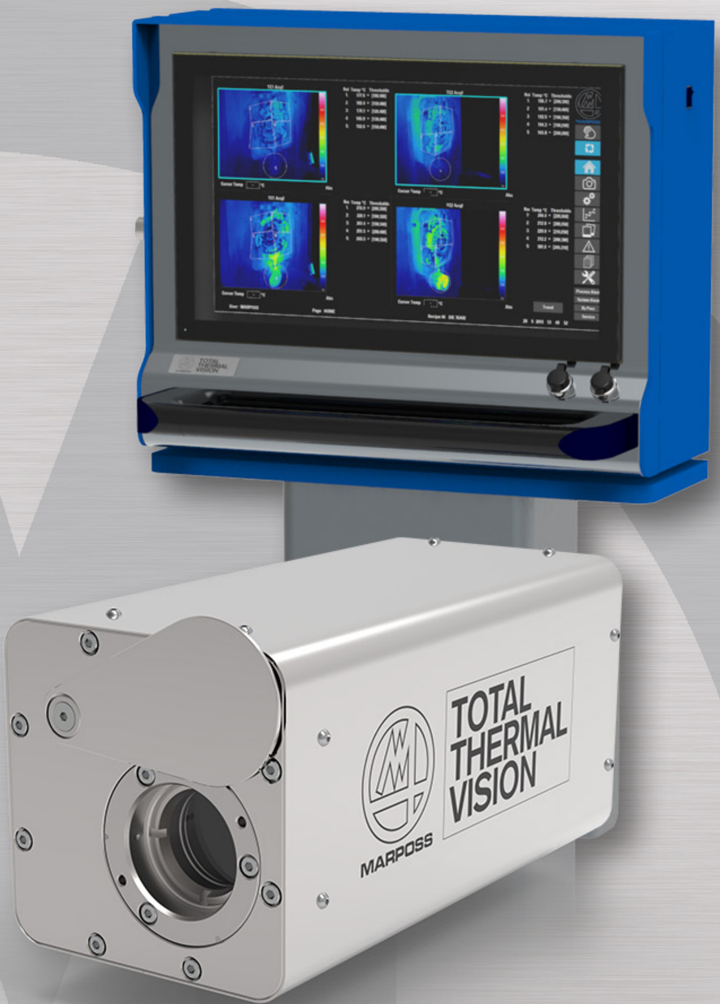
TOTAL THERMAL VISION

THERMOGRAPHIC PROCESS CONTROL



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System description

Die casting processes are used in light alloy foundries. In high pressure die casting, low pressure die casting and gravity die casting applications, correct temperature distribution on the die surface is crucially important for guaranteeing the efficiency and quality of the die casting process. Shrinking, porosity, cracking, blistering and a host of other defects may arise from an incorrect optimisation of the thermal distribution on the die. MARPOSS' Total Thermal Vision system plays a fundamental role in evaluating the temperature of the dies by means of infra-red imaging.

Die casting quality. Thermographic images acquired automatically while each cycle is in progress, either during the heating phase or during mass production, are used to correct the thermal balance of the die and monitor the die casting process parameters in real time.

In casting cells, it is fundamentally important to monitor the temperature and how it varies over the die surface. Die casting results depend directly upon the temperature level, while the way it is distributed affects how the heat is exchanged and hence the quality of die's being cast. By monitoring these factors and ensuring they remain under control it is possible to guarantee die casts without defects.

Save resources. Constant monitoring the die's surface temperature contributes significantly to prolonging its lifespan. It shortens cycle time and reduces unscheduled maintenance costs. Furthermore, monitoring and controlling temperature helps to limit the consumption of energy, air and release agents whilst also reducing the quantity of waste water.

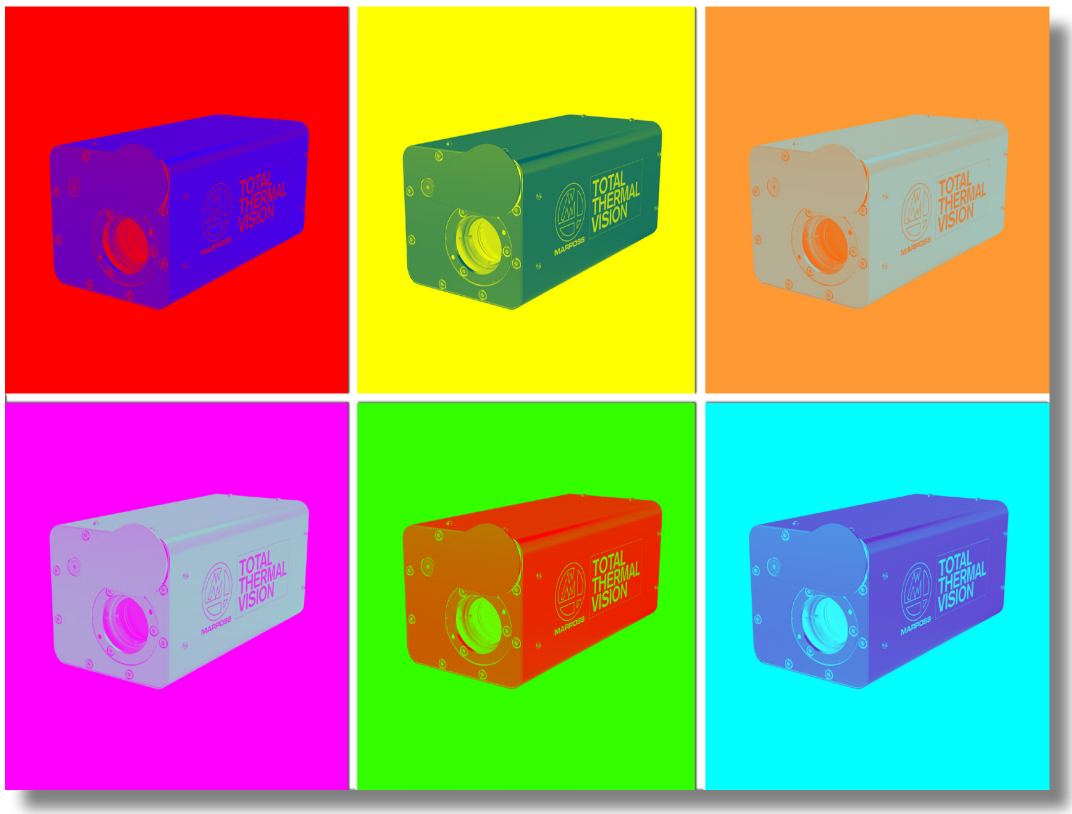
Considering this, TTV is the ideal solution for increasing cast quality and overall efficiency (OEE) in high productivity processes.

Benefits

- Improved quality and scrap reduction
- Productivity and reduced production costs
- OEE (Overall Equipment Effectiveness)
- Increased dies lifespan and less machine downtime
- Die casting cycle times optimisation and reduced restart times and costs
- Use of temperature data for integration with the thermo-regulator
- Data logging and batch certification

Typical applications

- High pressure die casting (HPDC)
- Low pressure die casting (LPDC)
- Gravity die casting (GDC)



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Optimisation of production process

Optimising in **high pressure die casting (HPDC**) processes represents a serious challenge, since the times needed by the majority of the individual operations, such as the piston stroke and die cast cooling phases, are largely fixed. The main area where it is possible to introduce improvements is the lubrication phase. The die cooling time may be reduced by determining the distribution of temperature on its surfaces. With the help of thermographic maps it is possible to identify the **critical areas** that need to be cooled, and by how much. In this way it is possible determine the length of time that is absolutely necessary to reach **optimum surface temperature.**
Reducing lubrication time will also result in an immediate reduction in cycle time. This phase may be optimised by balancing the quantity of release agent and water used. Customers who choose TTV benefit from reduced **warm-up time**, 70% less rejects and an increased **die lifespan**.

Low Pressure Die casting (LPDC) In the case of low pressure die casting, the presence of pressurised gases causes the liquid metal to rise within the die. By maintaining the pressure once the cavity has been filled, it is possible to compensate for the retraction phenomena that occurs during solidification. One phase of the process involves applying refractive paint to make it easier to detach the cast and improve the flow of the metal. It is relatively easy to optimise this phase, in terms of the quantity of paint required and the time taken to achieve correct thermal conditioning of the system, by using thermographic mapping. The TTV system is also used in this type of process to identify the critical zones, so that it is possible to implement the measures steps necessary to render a uniform die surface temperature distribution.
Customers that use TTV benefit from a net improvement in cycle times, excellent cast characteristics with precise surface features and hence, increased duration of the chill mould service life.

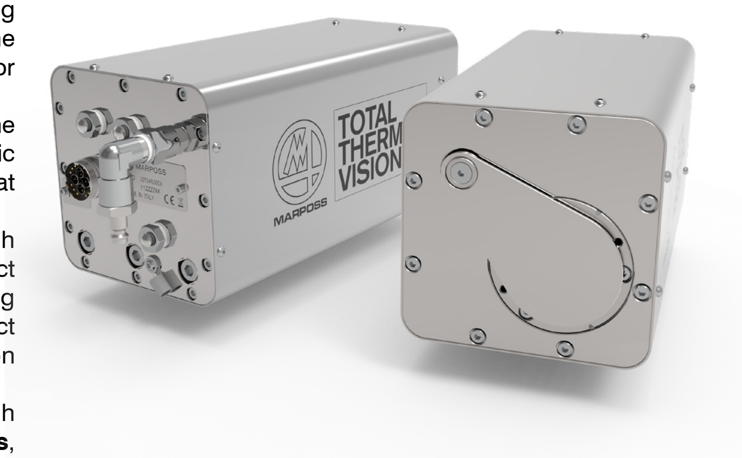
In the case of **gravity die casting (GDC)**, the metal is heated to a temperature only slightly above its melting point and poured into the metallic mould, where it solidifies rapidly. In order to ensure that the cast is detached correctly, protect the die and guarantee correct solidification, the metallic surfaces that come into contact with the molten alloy must be treated with refractive paint.
Thanks to the thermographic inspection, which forms an integral part of such processes, it is possible to optimise parameters such as the temperature of the moulds and the use of the chillers, as well as reducing both **pre-production and cycle time**s.
Customers that use TTV confirm **excellent cast characteristics** with precise surface features and an increased duration of the chill **mould service life**.

The TTV system communicates directly with the die casting machine, while exchanging data and information with other peripherals such as thermo-regulators, lubricator robots, etc. Thus, it fully satisfies the requirements of Industry 4.0, since it makes it possible to identify when the tolerance limits have been exceeded in real time and implement corrective actions to avoid producing large numbers of die casts that do not conform to the required quality standards.

Installing the TTV system on the machine guarantees a stable production process, and hence reliable die cast quality, as well as efficient machine operation and significant savings on production costs.

System hardware configurations

The thermographic images are essential for creating the surface heat-map of the mould and identifying the critical areas. Such images are acquired using **thermal imaging cameras** fitted with infra-red sensors that meet the requirements for use in foundries: ease of use, ruggedness and resistance to the adverse conditions present in the working environment.
The thermal imaging cameras are easy to install inside the casting cells and positioned so that they frame the die during the fully open phase, which occurs between the moment the newly produced die cast is removed and the preparation for the next cast.
Thus, the thermographic images are always acquired under the same process conditions, guaranteeing that the thermographic measurements are not affected by external factors, and that the production process is not interrupted.
The heart of the thermal imaging camera is the high performance **infra-red sensor**, which is housed in a compact protective casing, thermally isolated from the surrounding environment. The high definition sensor guarantees a perfect image of the die every time, regardless of the installation distance.
The Thermal imaging camera is also equipped with **acceleration, humidity, temperature and pressure sensors**, which are used to continuously monitor the operating state of the camera continuously, in order to guarantee precise, correct thermographic images, irrespective of the operating conditions.
The Thermal imaging camera is also fitted with a series of solenoid valves that regulate the cleaning air and the internal sensor cooling system.
The system is completed by a germanium window and a guillotine type shutter, which isolates the sensor's optics from the external environment and prevents it from being contaminated by foreign objects. Lastly, an optimised flow of compressed air ensures that the germanium window remains clean, while acting as a barrier against contamination from the surrounding environment.



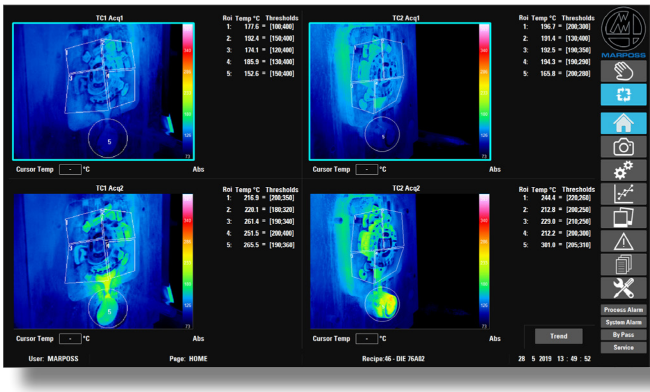
Thermal imaging cameras are connected to a control unit, which may be integrated with the machine control systems. For **greater flexibility** during the installation phase, the Controller is available in a variety of configurations: bench-mounted, on a feet or wheel-mounted support column, with the fittings required for a supporting arm. The control unit exchanges data and signals with the machine, enabling the cycle to be managed automatically while optimising the process parameters. Its architecture has been designed to be **compatible with all the various machine peripheral units**.
The TTV system uses communication protocols such as **physical Inputs/Outputs, Profinet and Ethernet IP** to exchange such information. All the units are operated by a 24 VDC power supply and equipped with a 21.5" PC **touch screen with graphic interface** for real time display of the images and data, which may also be analysed and subsequently saved subsequently. Cycle after cycle, TTV records and displays the temperature data in graph form so that the operator can modify the parameters promptly, if necessary, or analysis past process data. In fact, the heat maps for each die are stored, together with a series of significant data (ranges, alarms and configuration).

Software interface

TTV graphic interface displays the thermal map in real time and may be used to view the instantaneous surface temperature distribution of each die surface during the production process, without the need for interruptions.
Irrespective of the type of die, the Software may be used to set-up a recipe containing a series of parameters that define the number and shape of the ROI (regions of interest) and the respective temperature tolerance limits, generating an alarm if the **absolute temperature measurement value** is outside the limits set-up for each ROI. By capturing the images in the same region and during the same phase of the work cycle, the system guarantees that the measurements are both repeatable and comparable.
The images may be acquired using the **incremental method**. In this case, a master thermographic image may be used as the reference for subsequent acquisitions, while the process control comparison thresholds are referenced to the resulting incremental value.
The temperature information is expressed both as a numerical value and in terms of relative chromatic indications with respect to the Master image.
It is possible to save multiple recipes, which are easy to manage and may be reloaded each time the production batch is changed, resulting in increased operating efficiency.
The TTV system records, displays and saves images, complete with temperature values and in graph form, during each cycle. This information may be retrieved subsequently, together with the process alarms and control conditions, to monitor the progress of the work cycle.
By using the software analysis tools, it is possible achieve continuous improvements in the production process. This is thanks to an increased understanding and awareness of the production parameters on the part of the operators, technicians and quality control personnel.
The operator interface is available in all major western languages, in addition to Chinese, Japanese and Cyrillic characters.

HMI user interface functions

- Displaying single or multiple heat maps of the die.
- Processing polygonal or circular temperature control areas (ROI).
- Processing the maximum, average and minimum temperature values for each ROI, with measurement limits and respective alarms.
- Displaying the difference between the measured temperature values and the predefined sample values.
- Digitally zooming in/out on the images.
- Saving multiple recipes, thereby simplifying the production batch changeover and process data analysis procedures and rendering them more flexible.
- Displaying the temperature trend graph for each ROI.
- Saving images and data for local or remote post-process analysis.



Die heat map showing the processed temperature values and alarms where the temperature is outside the tolerance limits set-up for each ROI.

Analysis of the archived process data and graphic display of the trend.

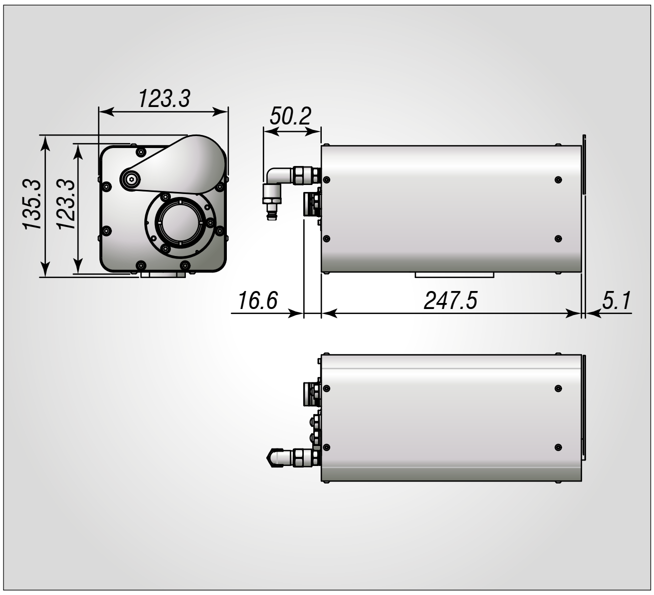
Thermographic image with temperature values for each ROI and recipe setup parameters

Thermal imaging camera

The thermal imaging camera includes the infra-red sensor, the electronic board and the solenoid valves.
The electronic board installed on the camera contains a series of diagnostic sensors designed to ensure correct operation and guarantee the quality of the measurements.

- Temperature sensor: this sensor controls the automatic cooling system, regulating the internal temperature of the camera.
- Pressure sensor: this sensor monitors the pressure of the internal pneumatic system, ensuring the air flow is sufficient to regulate the temperature and protect the optics from adverse environmental conditions.

The control unit connection cables have been redesigned so as to limit their radius of curvature and take up less space, available with or without protective metal sheathing.
The unit is also available with a graduated, adjustable support so that it can be aligned and regulated according to the requirements of the installation, while ensuring that any such adjustments are repeatable at a later date.



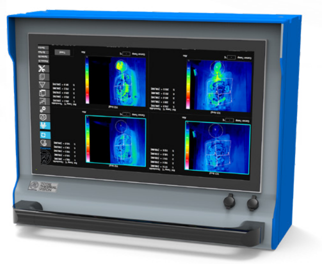
THERMAL IMAGING CAMERA UNIT WEIGHT	~4.5 kg
PRECISION	±5°C or ±5% of the value
RESOLUTION	640 × 512 px
MEASUREMENT RANGE	10 ÷ 550 °C *(50 ÷ 1020 °F)*
THERMAL SENSITIVITY/NETD	<0.05 °C at + 30 °C/ 50 mK
FIELD OF VIEW	45°(H) × 37°(V)
VIBRATIONS *(IEC 60068-2-6)*	39.2 m/s² (4g)
COLLISIONS *(IEC 60068-2-27)*	294 m/s² (30g)
OPERATING TEMPERATURE	-15 °C ÷ 50 °C
STORAGE TEMPERATURE	-40 °C ÷ 70 °C
ENVIRONMENT HUMIDITY	30% ÷ 80%
PROTECTION DEGREE *(IEC 60529)*	IP 65

Control unit

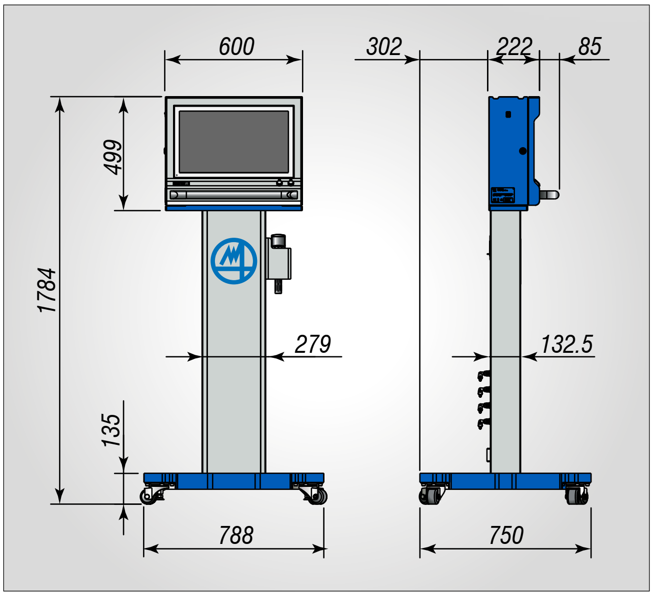
The controller is available in three configurations, so that it can be adapted to a range of machine layouts: bench-mounted, on a feet or wheel-mounted support column or with the adaptors needed for a pendant arm.
The control unit is based on the Marposs E9066T, and is equipped with a 21.5” touch screen monitor.
Thanks to Marposs technology, the unit may also be equipped with a dedicated remote service tool.

Control unit in support column configuration

Control unit with fittings for pendant arm



Bench-mounted control unit



WEIGHT	*with support column*	~100 kg
	supporting arm version	~30 kg
	for bench	~30 kg
OPERATING TEMPERATURE		-15 °C ÷ 50 °C
STORAGE TEMPERATURE		-40 °C ÷ 70 °C
ENVIRONMENT HUMIDITY		5% ÷ 80%
PROTECTION DEGREE *(IEC 60529)*		IP54

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