

# EpiCurve® TT for MBE systems

EpiCurve® TT is an optical in-situ sensor for monitoring of epitaxial growth. It features wafer curvature measurement, emissivity corrected wafer temperature and high-accuracy reflectance measurement for growth rate analysis.

## EpiCurve® TT features:

### Curvature

- curvature measurement with a 2-dimensional detection system
- includes RCD (reflectance compensation detection) for enhanced dynamic range

### Temperature

- true temperature measurements, pyrometer calibrated against a black body radiation source

### Reflectance

- reflectance measurements at two wavelengths: 950 nm and a customized second wavelength (405 nm or 488 nm or 633 nm or 950 nm)
- on-line wafer selective growth rate fits
- recipe controlled automated growth rate fit for multi-layer structures
- measurements on single and multiple wafers
- optimized for 24 h/7day operation in production environment

### Communication / integration

- data exchange with growth system control computer via hardware interface and/or TCP/IP protocol based software interface
- remote controllable from growth recipe (start/stop and marker)

### Measurable growth parameters \*

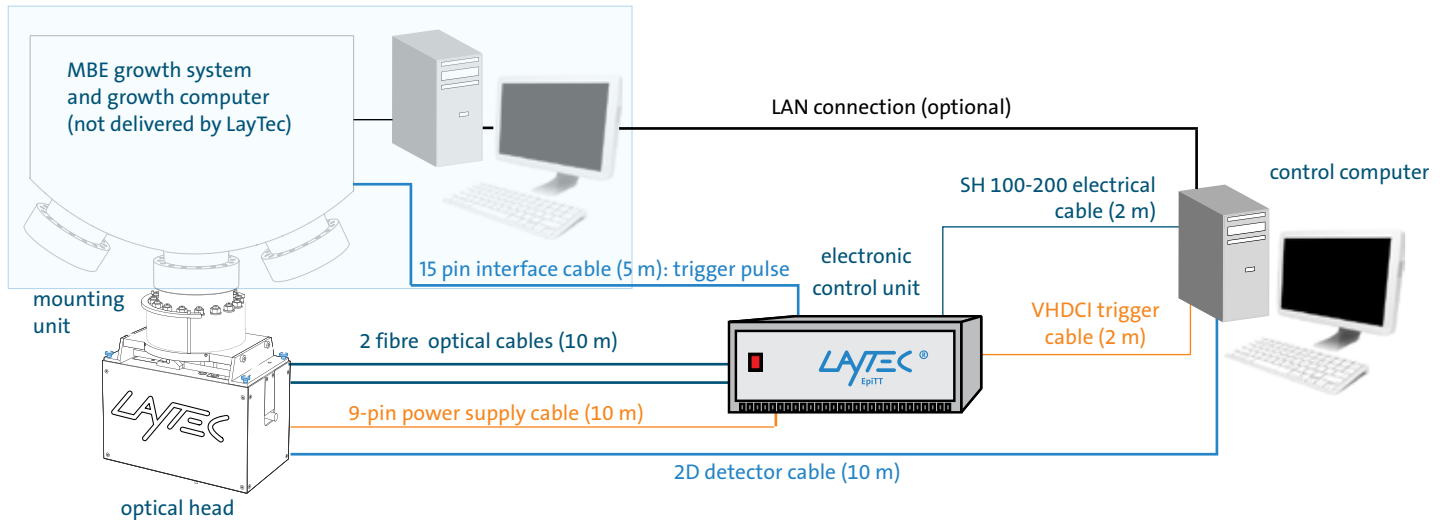
- wafer curvature 1/R, typical range:  $-200 \text{ km}^{-1}$  (convex) to  $+200 \text{ km}^{-1}$  (concave),\* typical accuracy:  $\pm 5 \text{ km}^{-1}$ \*
- reflectance: noise typically better than  $\pm 1.5\%$
- growth rate: typical accuracy better than  $\pm 1\%$  (down to  $\pm 0.001 \text{ nm/s}$ )
- wafer temperature: typical accuracy  $\pm 1\text{K}$ : temperature range:  $450 - 1300^\circ\text{C}$  \*\*
- composition monitoring: 1% for AlGaIn (>200 nm), 1% for InGaIn (>25 nm)

\*specification varies depending on the configuration of the specific MBE chamber

\*\* if not influenced by stray light of the window heater, sample heater or sources



# EpiCurve<sup>®</sup> TT for MBE systems: standard package



## Optical head for combined curvature, reflectance and wafer temperature measurements

light source for curvature measurements	compact 656 nm semiconductor laser
typical life-time according to manufacturer	> 20.000 h
light source for reflectance measurement	ultra high brightness LEDs
reflectance measurement wavelength and bandwidth	633 nm $\pm$ 1.5 nm or 405 nm $\pm$ 5 nm or 488 nm $\pm$ 5 nm or 950 nm $\pm$ 1 nm
pyrometry wavelength and bandwidth	950 nm $\pm$ 5 nm
typical sampling rate	reflectance / temperature: 100 Hz curvature: 10 Hz
data repetition rate	1 revolution of wafer carrier

## Electronic control unit

The control unit is a standard 19" case that can be easily mounted into existing 19" racks. It is connected with the control computer and the growth system as shown in the drawing above.

## Cables

- 2 optical fibres (optical head <-> electronic unit): 10 m, core diameter 600  $\mu$ m, special vis-IR transparent material, minimum bending radius 36 cm
- 9-pin power supply cable (10 m, optical head <-> electronic unit)
- 2D detector cable (10 m, optical head <-> computer)
- SH 100-200 electrical cable (2 m, electronic unit <-> computer)
- optionally, a KVM extension set (cable or ethernet based extender) is available
- 15 pin interface cable (5 m, electronic unit <-> growth system): transfers the trigger and marker signals; exports analog voltages proportional to the measured temperature and reflectance (see "communication with growth system" below)
- VHDCI trigger cable (2 m, 2D detector unit <-> computer)
- multi-plug and power cables

## Control computer

- 19" rack mount control computer
- CPU: Pentium Core 2 Duo, min 1.66 GHz, RAM min. 1 GB
- HDD min. 160 GB, RAID 1
- DVD-writer, card reader, mouse, keyboard
- 100 Mbit/s LAN interface or better
- operating system: Windows XP pro MUI (multi language version)
- 19" TFT flat screen (monitor resolution of 1280 x 1024 or higher)

# EpiCurve® TT for MBE systems: standard package

## Miscellaneous items

- MBE chamber specific rotation trigger sensor
- MBE chamber specific mounting and adjustment unit
- manual and software CD
- additional USB license dongle for growth rate analysis and growth rate fit on office computer
- backside metallized Al-Si eutectic wafer for temperature calibration (special coated 2", 3" or 4" wafer)
- curvature calibration wafers (2"), one convex and one concave, pre-characterized (adaption rings for other wafer sizes on request)

## Communication with growth system

The electronic control unit is connected with the growth system by 15 pin interface cable (trigger pulse is mandatory). Optional LAN connection to growth control computer is available. **Please note:** for the LAN connection a special software interface on the growth system computer is necessary. The interface should be arranged by the customer with the manufacturer of the growth system. The table below demonstrates which data is transferred from and to the growth system.

Communication features	15 pin interface cable	LAN connection
rotation synchronous trigger pulse or (once per susceptor revolution) from growth system *	5V TTL or open collector signal	–
2 digital signals to growth system indicating heartbeat and busy/error status	5V TTL or open collector signal	–
start/stop signal from growth system for remote control from the recipe	5V TTL or open collector signal	via TCP/IP
reflectance calibration signal from growth system to indicate substrate reflectance	5V TTL or open collector signal	via TCP/IP
up to 3 marker signals to indicate different growth steps and for data synchronization with the growth recipe	5V TTL or open collector signal	via TCP/IP
process temperature from thermocouple or Eurotherm for advanced logging and calibration purpose	analog voltage (0-10 V)	via TCP/IP
pyrometer temperature to growth system for export of measured temperature	analog voltage** (0-10 V)	via TCP/IP (all wafers individually)
reflectance signal to growth system for export of the measured reflectance	analog voltage** (0-10 V)	via TCP/IP (all wafers individually)

## EpiCurve® TT size and weight

Parts	Size X x Y x Z mm	Weight, kg
optical head without mounting tool	284 x 165 x 170	3.5
control unit (19" case 4 HE, 84 TE)	450 x 300 x 180	8.0
rack mount control computer (4 HE)	450 x 600 x 180	17.0
19" LCD display	410 x 20 x 420	5,5
mounting and adjustment unit (reactor specific, here an example)	246 x 165 x 257	1.2

\* this line is mandatory for multiple wafer systems and strongly recommended for motor driven single-wafer systems

\*\* in multi-wafer systems only averaged data or data from one specified wafer can be transferred

# EpiCurve® TT requirements to MBE system

## Requirements to the growth system

- heated normal-incidence optical view port to avoid or reduce window coating
- in case of strong window coating we highly recommend a periscope solution for the view-port
- free optical access to the sample
- rotation synchronous trigger pulse from rotation axis, one pulse per revolution (TTL or open collector)
- if no rotation trigger pulse is available, LayTec provides photo-relay based solutions if there is an access to the rotation axis
- main rotation frequency below 20 rpm
- no cryo-shields or shutters in the light-beam path during measurements and no additional apertures
- the above specified temperature features are provided if stray light effects are avoided and for backside coated wafer
- for curvature measurements strong sample wobbling has to be avoided
- enough space around and on top of the view port for the optical head

## Operating conditions

Component	Allowed temperature range	
	operation	storage
optical head	10°C – 40°C	10°C – 60°C
electronic control unit	10°C – 35°C	10°C – 60°C
control computer	10°C – 35°C	10°C – 60°C

## Please note:

- vibrations of optical head have to be avoided during the measurement
- optical head is fragile, avoid shock-treatment
- warm-up time: 15 min

## EpiCurve® TT electrical connections /power consumption

- the main connection (100-240 V) including extension cables to the control unit has to be provided by the customer
- input voltage: 100/240 V auto detect
- the power supply must be equipped with grounding wire
- power consumption (typical values for 230 V operation):

Component	current/A	power/W typical	power/W max.
control computer	3.5	134	500
monitor	1.5	26	40
control unit rack	0,3	20	70
total	5.3	180	610

## EpiCurve® TT is available for:

- MBE systems by Riber, Veeco/Applied Epi, VG, DCA
- home built MBE systems
- All existing EpiTTs can be up-graded to EpiCurve® TT!
- EpiCurve® TT can be adapted to virtually any growth system.

Specifications are subject to further technical development and may differ from those given in the datasheet.

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