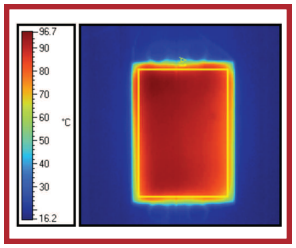
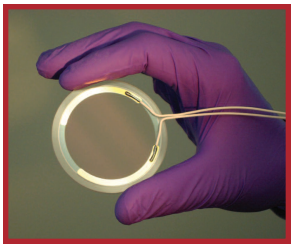
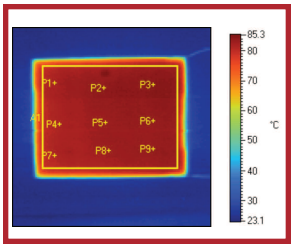






Therma Klear™ Series Transparent Heaters

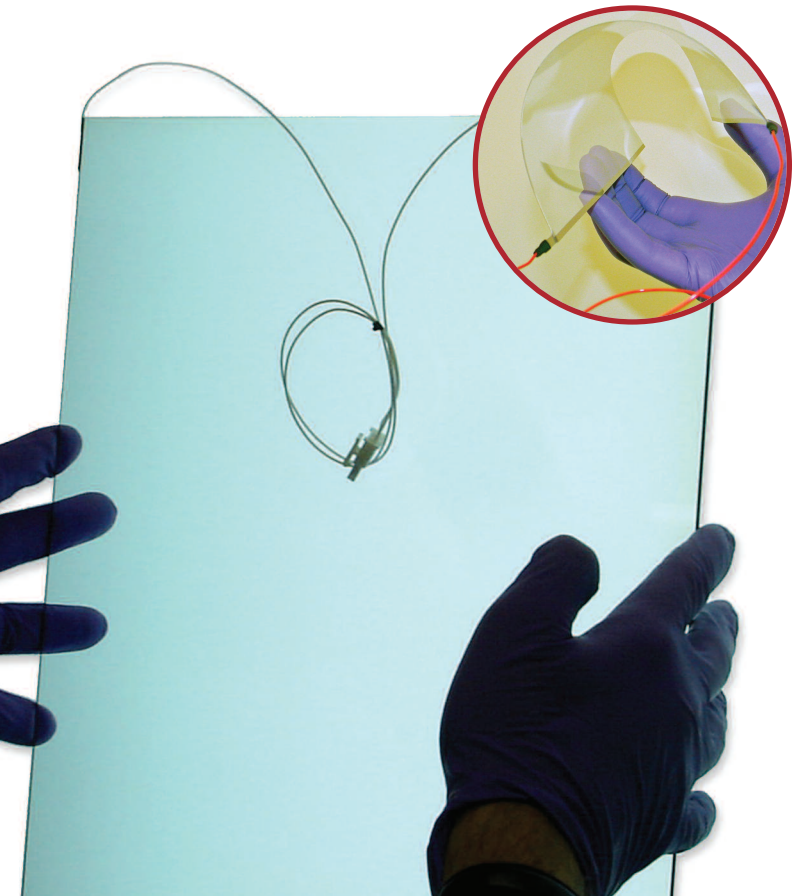
Dontech Rigid and Flexible Transparent Heaters

Dontech Therma Klear™ Series transparent heaters provide custom, low temperature control solutions for precision optics, cameras, imaging systems and electronic displays such as LCDs.

Typical applications for Dontech transparent heaters include anti-fogging, anti-icing, de-fogging and de-icing of avionic displays, rugged computers, outdoor surveillance systems and handheld electronics.

Dontech's Therma Klear™ heaters provide LCD operation to below -65°C and can be configured for mounting in front of or behind a display or precision optical assembly, or on the rear surface of a touch screen.

Heaters can be combined with other performance-enhancing features (e.g., EMI/RFI – electromagnetic/radio frequency interference shielding), and can be equipped with optical adhesive for Therma Klear™ Flex heaters.



Dontech Therma Klear™ Flex heaters are constructed using single- or multiple-layer thin film conductive coatings in sheet resistances of 5 to 200 ohms/sq. The heaters are typically 0.007" thick and require very little room for integration into a display assembly or on the rear surface of a touch screen.

Standard Heater Specifications:

- Substrates – include various crystalline, glass (e.g., soda-lime or borosilicate glass), acrylic, polycarbonate, polyester and triacetate materials
- Sizes from <1.0" to >60.0" diagonal; thickness from 0.003" to 1" (substrate and size dependent).
- Shapes – rectangular, round or custom; flat and formed
- Sheet Resistance – <1 ohms/sq. to >350 ohms/sq.

Custom Heater Specifications and Options:

- Indium Tin Oxide (ITO) heater coatings can be index-matched to maximize light transmission (up to 98%, coating and substrate dependent). Index matching can be adjusted to air, to the substrate, or to any optical adhesive and optimized for angles from normal to 60° and enhanced for visible and NIR applications.
- Custom wire attachment via a Dontech proprietary attachment process, providing mechanical durability and uniformity. Standard processes include mechanical clamps, soldering, and conductive adhesives.
- Bus bar options:
  - Solderable: Silver (Ag) fritted ceramic, thin film deposited metals
  - Metal loaded: polymers, acrylic, polyester, and epoxy based chemistries
  - Common conductors: Silver, gold, copper and nickel
- Temperature sensor: heaters can be equipped with a thermistor or resistance temperature detector (RTD) for feedback into a controller for temperature regulation to prevent thermal overruns.
- Dontech can optically bond heaters to the optical assembly to reduce reflections, increase durability, and mechanically couple the optical elements for better thermal transfer. Heaters can be bonded to touch screens and to the front or rear surface of LCDs.
- Transparent heaters can be configured to provide EMI/RFI shielding of displays (e.g., LCDs) or precision optics.

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Dontech Rigid and Flexible Transparent Heaters

The conductivity of Dontech Transparent heaters can be specified in sheet resistance or line resistance. Sheet resistance (R) is expressed in ohms/square and is used to quantify the conductivity of the thin film coating. Dontech's transparent conductive coatings are designated as VC Series coatings. Line resistance (R_L), expressed in ohms, is the wire-to-wire resistance of the heater or the total resistance the power supply will see. When power is applied to a transparent heater, the resistance of the conductive coating to the electrical current flow generates heat. The amount of heat generated is dependent on the heater and bus bar geometry, the voltage applied, and the sheet resistance of the VC Series coating.

Dontech VC Series coatings are available in a wide range of resistances and can be cost effectively applied to most standard optical substrates. These coatings are neutral in color, high in light transmission, and ideal for visible or NIR applications. Surface reflections can be minimized and transmittance can be maximized by index matching the conductive coating to air, substrate, or lamination adhesives.

Standard Coatings	Maximum Resistance	Nominal Unenhanced Transmittance	Nominal Enhanced Transmittance
VC1-1	1	80%	88%
VC1-2	2	83%	90%
VC1-5	5	85%	91%
VC1-10	10	89%	94%
VC1-15	15	89%	94%
VC1-25	25	89%	94%
VC1-60	60	90%	96%
VC1-80	80	90%	96%
VC1-100	100	90%	96%
VC1-150	150	90%	97%
VC1-350	350	90%	98%

Note: Transmittance values will vary with deposition process, enhancements, hard coatings and substrates. These values are for reference purposes only. Please contact a Dontech Engineering Representative for design information specific to your application.

Electrical contact with the conductive heater surface is established with two high conductivity bus bars formed with opaque conductive materials (e.g., silver, gold, nickel and copper). These bus bars are generally located parallel to one another on opposite sides of the heater. Applying the bus bars to the long sides of a rectangular heater provides more efficient heating. Wire leads can be applied to the bus bars for ease of connection to the power supply and controller.

The proper resistance range of the heater is best determined from the heating power required, the source of applied voltage, and the intended use. For instance: for anti-fogging, a power density of 0.5 to 1.0 watts/square inch is commonly used. For de-icing, a higher power density (e.g., 4 or 5 watts/square inch) may be required. The total power required is specified in watts per area. Recommended power densities for Therma Klear™ heaters are from 0.1 to 5.0 watts per square inch. Higher power densities are only compatible with glass and crystalline substrates, as the high coefficient of thermal expansion of most polymers can destroy polymer heaters when run at high power densities. In most cases, heaters should be attached to a feedback control system to turn the heater on and off as needed to prevent thermal runaways from occurring.

Heater Calculations:

R = The sheet resistance (ohms per square) of the VC Series coating

R_L = Wire-to-wire resistance (ohms) or approximate nominal line resistance *Note: Equations #1 & #3 assume there is no appreciable resistance from the bus bars, lead wires, or the connection points of the wires to the bus bars.*

V = Applied voltage (volts)

PD = Power density (watts per square inch)

PT = Total power of the system (watts)

L = Length of conductive coating (inches)

W = Width (i.e., separation between inside of bus bars) of conductive coating (inches)

A = Area of heater (square inches)

Equations (Equations 1 and 3 only apply to rectangular heaters):

Equation 1: $P_D = \frac{V^2}{RW^2}$

Equation 2: $P_D = \frac{P_T}{A}$

Equation 3: $R_L = \frac{RW}{L}$

Equation 4: $P_T = \frac{V^2}{R_L}$

Dontech is an ISO-9001/2008 certified designer and manufacturer of optical filters for electronic displays (LCDs) and precision optics. Our optical filters can be supplied stand-alone, or we can incorporate them into the next higher assembly for our customers (e.g., optically bonded to a display or touch screen, or mounted in a mechanical frame). For custom solutions or additional technical information, please contact a Dontech Sales or Engineering Representative at (215) 348-5010.

Visit us at **www.dontech.com** for more information.

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