information from PLESSEY

100 x 100 PYROELECTRIC IMAGING SUBSYSTEM

PROVISIONAL SPECIFICATION

The 100 x 100 imaging subsystem features an uncooled pyroelectric IR detector array with associated chopper and signal processing electronics providing a video standard output. The array utilises a germanium window with long wave pass filter coating, cut-on wavelength 6.5µm ± 0.5 µm, transmission ≥70% over the range 7.5µm to 13µm and <0.1% average below passband.

Number of Elements	10,000
Element Pitch	100µm x 100µm
Responsivity	0.98mV/K at 25Hz frame rate after the image difference processing, referred to the output of the detector hybrid operated in the field reset mode with f/1 optics.
Uniformity of Responsivity	Maximum ±10% variation over all operational elements. Minimum operational elements =99%.
Noise	500µV r.m.s. after IDP, referred to the output of the detector hybrid operated in the field reset mode at 25Hz frame rate.
NETD	0.5K at 25Hz frame rate in the field reset mode at zero spatial frequency.
Output	CCIR Video
Approx. Physical Dimensions (no lens)	300mm x 80mm x 120mm

For further information please contact the marketing manager at the address given below.

PLESSEY

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Roke Manor Research 100x100 Pyroelectric Thermal Imager RIS-2D-03

General Description

The imager is designed to operate with 100x100 detector arrays, complying with the VX9597 detector specification. As presently designed the imager performance is detector limited, and any defects in the detector in the form of element drop-out or excessive responsivity variation will be manifest in the displayed image. If dead element and responsivity correction is required, this may be incorporated as an extra facility.

The imager design has concentrated on obtaining the best performance from monolithic detectors, and incorporates a miniature CRT display and CCIR video output. It is configured as three separate units, the head, processing and battery units respectively. This approach to the design minimises the size of the sensor head, making it easy to hold, and allows the processor and battery units to be mounted on the users belt or in a carrying pouch.

The CRT display is mounted in the head, and includes an eyepiece with focus facility. The system gain and offset controls are mounted in the rear panel of the head, the gain being adjustable in fixed steps and the offset being continuously adjustable.

The processor unit includes three toggle switch controls and a pressure key pad control. One toggle switch powers the imager up or down, the second switch turns the internal display on/off, the third switch locks the key pad settings. The key pad is used to control the imager frame rate, the contrast, the frame freeze and the cursor format and position.

PRINCIPLE OF OPERATION

The scene is imaged on the detector by an objective lens. The radiation incident on the detector is modulated by an umbral chopper, configured as a thin, rotating disc with a spiral aperture. The chopper blade is located as close as possible to the image plane, in order to maximise the optical chopping efficiency. The spiral blade edge is arranged with respect to the detector array so that it obscures the array from the scene illumination in a line-by-line progression. The output from the detector is clocked out continuously and in synchronism with the chopper blade's movement across the array.

The processing electronics carries out a three stage process; coarse offset removal, image difference processing (IDP) and scan conversion for display on the CRT. Offset removal is effected by storing the digital values of the detector output for the chopper closed field in a reference memory, and subtracting these from the subsequent chopper open and closed fields in the analogue domain in real time pixel by pixel. The data values are digitised and the difference between them calculated by the image difference processor to provide image data. The chopper closed data in the reference memory is then updated and the process starts again.

The image data is then displayed on a TV display via a scan converter.

Configuration

The imager is currently configured as three units:

- The imager head.
- Processing unit.
- Battery unit.

The imager head contains the infrared lens, the chopper, the detector, the detector interface electronics and the miniature CRT display module.

The head is linked to the processing unit by an umbilical cable 1.5 metres long. The processing unit contains the analogue signal conditioning electronics, the digital signal processing electronics and the power supply conditioning electronics.

The processing unit is linked to the battery unit by a cable whose length may be specified by the user, nominally 1.5 metres long. The battery unit contains a Nicad battery pack, complete with battery charging management electronics. The battery is charged via the socket used to supply power to the processor; the battery cannot be charged while the imager is in use.

The imager is also available in a single unit configuration, with an integral display.

SPECIFICATION.

General.

Detector:	100x100 element pyroelectric based on VX9597.
NETD:	Defined by detector performance (less than 0.5K) for f/1 optics
MRTD:	As shown in Figure 1
Field of View:	22.5 degrees with 25mm lens. The lens mount is standard Wreathall Thread, and a range of lenses are available.
Displayed scene temperature range:	4K, 8K, 16K or 32K
Offset range (sensor to mean scene):	+20 to -50K
Frame rate:	25Hz.
Cursor:	Adjustable crosshair electronically generated.

Chopper.

4 field spiral bladed.

Electronics.

Offset Removal:	8 bit Coarse Offset Processor.
Processing:	Two point Image Difference Processing.
Responsivity Correction:	None
Dead element correction:	None
Video Output:	CCIR compatible.
Display:	Miniature CRT.

Battery Pack.

Type	Rechargeable.
Lifetime	>2 hours

Dimensions.

Processor:	290x110x90 mm excluding connector.
Head:	90x170x100 mm excluding controls, lens and display eyepiece.

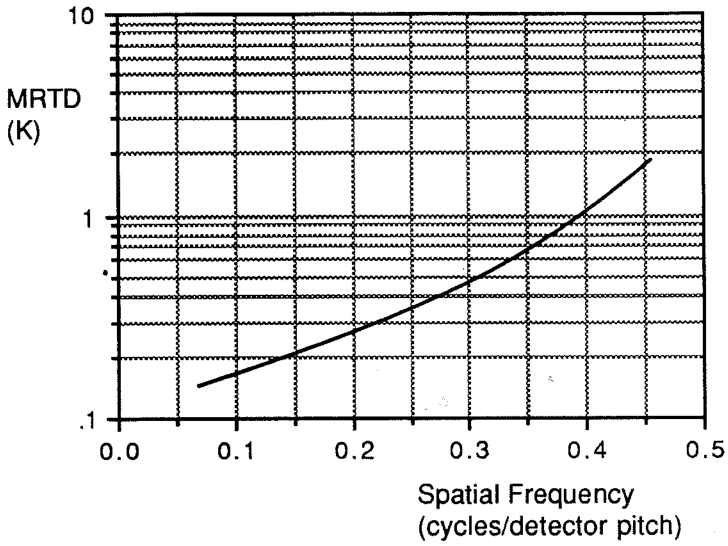

Figure 1. Typical MRTD plot, f/0.7 optics.
The absolute values of MRTD for a given imager will depend on the characteristics of the detector and optics fitted.

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Readout

A room temperature infra-red camera

AS PART OF A European collaboration on automotive electronics, a thermal infra-red camera that operates at room temperature without the need for cooling has been developed that could be produced cheaply enough to mount on a boat to add visibility, as suggested in *Electronic Engineering* November 1991 p37 to prevent disasters such as the Marchioness.

The camera is being used by a team from Lucas Automotive, Jaguar and Pilkington, and is mounted in a "concept" vehicle as part of the Prometheus programme.

The technology has been developed under MoD funding by the Royal Signals and Radar Establishment (RSRE) at Malvern, using a material developed by the GEC-Marconi Materials Technology Group at Caswell for the imaging element.

The prototype used in the Prometheus has been built by RSRE who are negotiating the production of the camera with a number of companies, including GEC-Sensors at Basildon, Essex.

"Staring" array

The key to the camera is the sensing element - a 100 x 100 "staring" array of pyroelectric elements. The pyroelectric effect is the same consequence of permanent dipoles that leads to the piezoelectric effect except the degree of polarisation depends on the temperature of the material. The use of a staring array generates a "heat map" with a 1:1 correspondence between the image and the data, and this means the element does not require an optical scanning method, such as a raster scan, which reduces the complexity of the camera. The drawback of the 1:1 correspondence is that to get a better spacial resolution, a larger array must be used, or the field of view reduced.

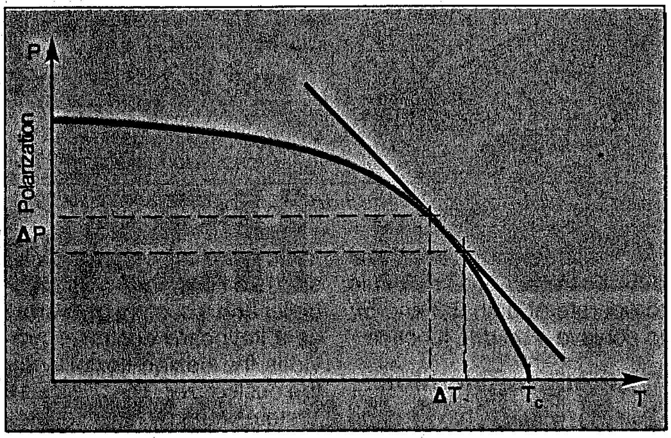

Figure 1: Change in polarization with temperature for a pyroelectric material

The material used is PZNFTU, a ceramic of Pb, Zr, Nb, Fe, Ti, U and oxygen, that has a Curie temperature (T_c) of around 300°C. This is the temperature at which the spontaneous polarisation disappears, and the high T_c allows the sensor to operate over a wide temperature range, including room temperature, with high sensitivity (see figure 1).

An image is focussed through a solid germanium lens onto the array, which has a thermal absorber on top. As the temperature of each element varies, the polarisation changes. The element temperature changes by 80μK for each 1K change in the scene temperature, producing 150μV of signal on a detector capacitance of 1pF. The rms noise equivalent of the element is 0.2K, but the minimum resolution of 0.1K is based on the perception of the image by a viewer.

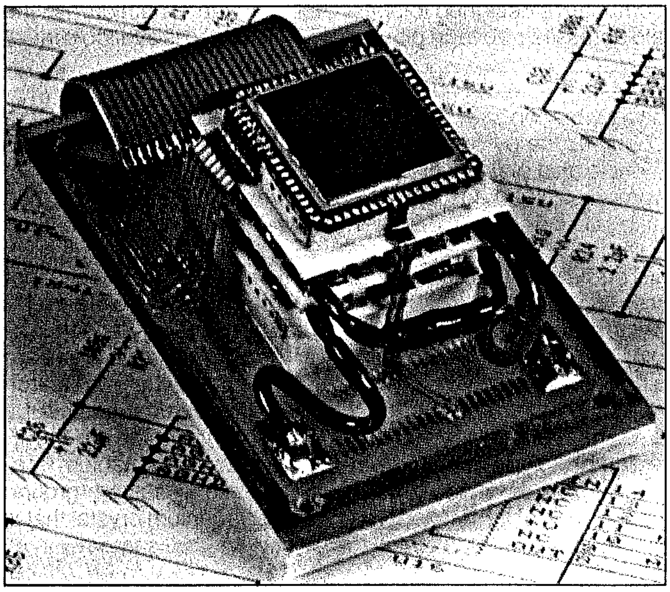

Figure 2: RSRE's pyroelectric detector

Mechanical chopper

The temperature is determined by measuring the voltage from the illuminated element, and comparing this with the voltage generated from the element with a constant, reference, "image". This reference is supplied by a mechanical chopper in front of the array giving a constant temperature.

The value from the image is digitised and stored, and then subtracted from the digitised reference value. The values are "read" by a MOSFET network on the hybrid substrate, which is synchronised with the chopper.

The chopper operates at 50Hz (where a cycle is one open, one closed), and the elements are sampled at the maximum and minimum values of the voltages as the reading changes from the image to the reference and back again.

The sensor itself operates over the temperature range of -30 to 40°C.

The array in the prototype camera is monolithic, so that the 100 x 100 array is defined by the electrodes on the ceramic material.

One of the problems is that the heat in one area tends to spread into other elements, especially if there is a particularly hot object in the image, reducing the resolution.

RSRE have developed a reticulation process, where the

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The move to 3.3V gathers pace via Triathlo

WHEN THE IDEA of a move from 5 to 3.3V was first muted it was driven by a recognition that if photolithographic scaling exercises continued unabated, such a move would become a necessity. This was because the resulting submicron devices would not be able to sustain 5V.

What is interesting about the 3.3V developments of the present is that while the scaling exercises continue much of the move to 3.3V is being driven by an application — the laptop or portable PC.

The need to reduce power by power management techniques (see *Electronic Engineering* November 1991 pp43/52) is being pursued combined with techniques such as: sleep modes, reduced clock speeds and static designs.

However the ability to drop the supply voltage to 3.3V, without compromising performance provides a dramatic power saving.

Transition period

It was also clear from the outset that for what was likely to be a long transition period designers and components would need to be able to operate in a mixed 3.3 and 5V environment.

At the device level the mixed supply would serve a core operating at 3.3V and a periphery and I/O operating into a 5V world. At the board level devices might need to be able to operate at both 3.3 and 5V to achieve a unique function.

	Availability — Timing		
	3.3V/LV version	4.3V	5V
7910	Feb 7, 1992	N/A	Feb 7, 1992
76C20	Jan 15, 1992	N/A	Now
76C30	Jan 15, 1992	N/A	Now
90C26	Samples Nov 91 Production Q192	⇐same device	Not available
90C63	Now	Now	Now
90C31	N/A	N/A	Samples now Production Q192

Table 1: Availability statement for the devices used in the Triathlon

Enter the Triathlon

Western Digital have been concentrating their efforts on developing a family of 3.3V devices. With a number of those devices now released they have decided to force the pace with a computer design called the Triathlon. The Triathlon is an AT compatible computer and is intended as a development platform for laptops. It will be followed by similar designs for: notebook/palmtop/tablet-notepad systems. It uses a low voltage processor, the AMD 386SX, a 3.3V version of the 386SX. The computer is designed to operate across two voltage planes.

On the 3.3V side the inclusion of a Hitachi H8 microcontroller and a custom gate array as a keyboard controller provides the design flexibility for the customizer. The 256k x 16 system memory also resides on the 3.3V voltage plane.

Laptop device set

Western Digital's devices for the Triathlon are the 7910LV, a system and cache controller, which is a derivative of the earlier 7610. Features of the device are a 386SX interface; two way set associative cache; internal tag memory and 8k of data RAM.

The device is packaged in a 160 pin J-lead plastic package and is fabricated in 0.9μm CMOS. The peripheral controller for the Triathlon is the 76C20 which is available in 3.3 and 5V versions. Featu clude floppy disc co and data separator; IDE disc interface; real time with memory and power agement. It is packaged 84 pin J-lead package a fabricated in a 1.2 process.

The 76C30, the I/O fun controller, is designed in 3.3 and 5V. Features inc two serial ports with bu FIFOs, bi-directional par ports, system clock ge ators; interrupt multiplexer power management. Fabri tion and packaging is as previous device.

Within the Triathlon the V controller, the WD90C operates on the 3.3V pla but within the computer mounted on a daughter boa The daughter board operat at 4.4V so that if and when t 3.3V plane switches to 5V t maximum operating value 4.4V will not be exceeded.

Features of the 90C26 are page mode memory interface zero wait state support, 16 b I/O and a high performanc 90C11 VGA core. The control ler is capable of supporting displays up to 1024 x 768 pixels at sixteen levels. Highe true colour with up to 256 le vels are possible at 640 x 480 pixels. The VGA controller can also support the simultaneous display between a CRT and colour TFT colour LCDs.

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elements are separated by a 10μm gap that is photochemically etched into the ceramic.

This reduces the lateral thermal spread, improving the resolution of the sensor.

The elements are mounted directly onto the silicon readout chip using a good electrical but bad thermal contact (to maintain good thermal isolation). This is achieved by keeping the area/volume ratio of the solder connections low, to give a limited thermal connection.

The element also has to have vibration taken into account, as the pyroelectric element is also piezoelectric and compression of the ceramic also causes a change in voltage.

The field of view of the camera can be set by choosing an appropriate lens, for example, a 50mm lens produces a field of view of 12°. Larger arrays than the current 100 x 100 are planned.

The prototype camera currently uses around 9W of power, but a production version would reduce this to around 3W.

GEC-Sensors believes that it is possible to manufacture the camera now for £10,000 per unit, and in the long term of 2-3 years they could more than halve the cost to less than £5,000. For applications such as a boat camera, this cost per unit could be possible in 1-2 years, says GEC-Sensors.

The cost sensitive areas are the sensor, where research should reduce the cost, but a cost limiting factor are the IR transparent germanium optics. These lenses are ground from germanium crystal that is mined in the same way as quartz, making them an expensive part of the system.

One area for further research has to be the development of a low cost material, transparent in the 8-12μm range that is easily manufactured into optical elements.

GEC-Sensors expects to double the spacial resolution of the prototype camera for a production model, and the 3 PCBs for the signal processing in the prototype have been combined into one PCB using surface mount techniques for the production model.

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