DIGITAL DISPLAY SOLUTIONS FOR SMART BUILDINGS

INTELLIGENT ENVIRONMENT CONTROL AT OUR FINGERTIPS

At the forefront of digitally automated buildings is the central role of Human Centered intelligent display touchscreens

4D SYSTEMS
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WHITE PAPER

4D SYSTEMS
MAKING HUMAN INTELLIGENCE SMARTER
www.4dsystems.com.au

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1. INTRODUCTION

Smart building technology is at the heart of an increasing development of sustainable and smart cities. Similarly, standalone buildings – from hotels and commercial spaces to residences and industrial facilities – are already embracing automation systems that increase the quality of living by improving residents' living conditions and creating better working environments for employees. Smart buildings incorporate Building Automation Systems (BAS): technologies which are used to automate a building's physical environment to control conditions for energy conservation, safety and security, work productivity, as well as customised micro-environment experience for the occupants. Building automation systems have undergone significant evolution over just the past decade. And, with the introduction of IoT and 5G, the BAS technology sector is set to be a central part of new buildings and cities.

BAS have many advantages that significantly improve building environments, for example they provide:

- Better energy efficiency
- Reduced impact on the environment
- Greater systems automation
- Lower maintenance cost
- Increased revenue and savings due to all the above

Environmental sustainability and lowering energy consumption- and therefore increased savings and revenue - are significant considerations in BAS.

1.1 IoT: Driving The Smart In Buildings

A significant consideration when it comes to BAS is the Internet of Things (IoT), that helps connect a variety of devices and sensors to the internet, collecting data which then help deliver improved efficiency for owners and occupants of buildings. BAS leverages this, utilising a combination of software, hardware, and communication systems that measure and control a building's multitude of operations that improve efficiency, comfort, and safety. IoT makes communication possible and drives data connectivity in smart buildings.

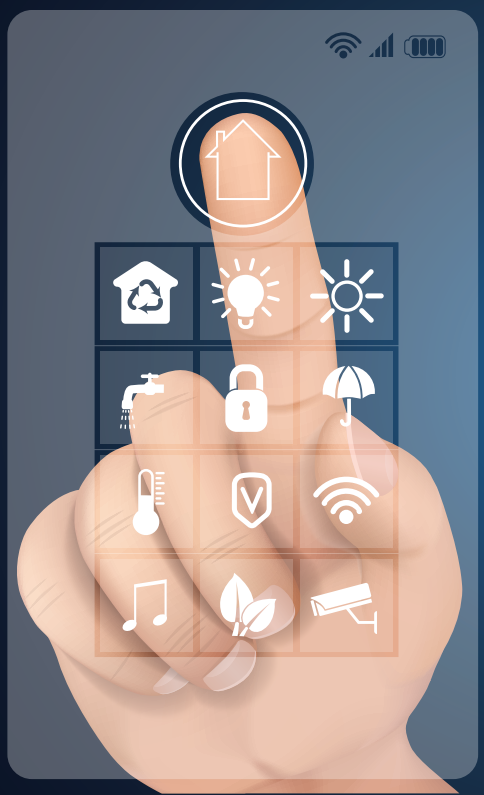
On the surface level, it may seem like Building automation systems, amplified via IoT, take human decision-making out of the loop because automated systems are often more efficient, and standardised through predictive technology that data drives.

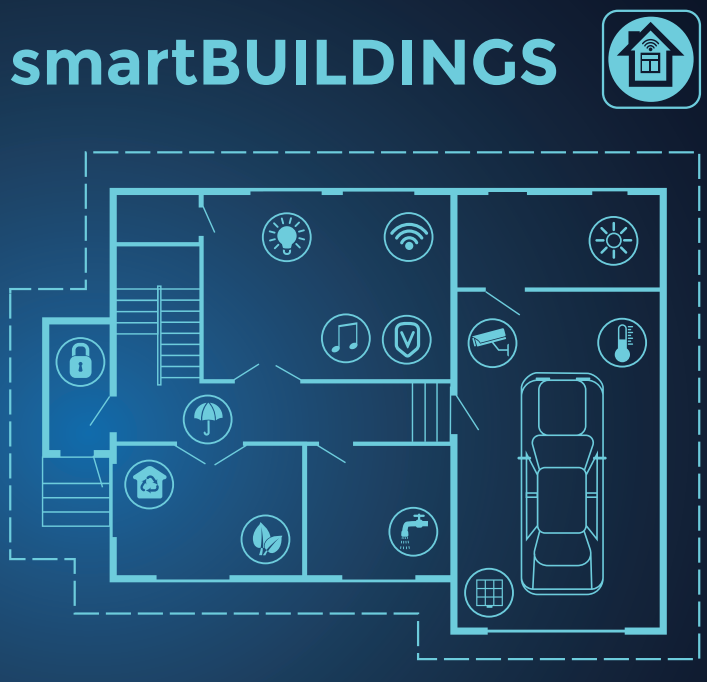
In reality however, building automation systems help humans make better decisions through intelligent data behind the micro-environment.. In fact, intelligent human choices are improved through BAS through two specific routes:

(i) Automated analysis and application of data collected via various touchpoints through sensors. In this part of the overall ecosystem of BAS, the human plays little to no role because digital technology does a far better job at analysing data as well as control a large number of standard and predictive scenarios;

(ii) Human choices that utilise the data analysed by BAS, at the touch of a button, **through smart display solutions**.

Human intelligence is crucial when it comes to making choices that are personalised and non-predictive. And, display solutions are at the centre of the intersection between automated data and control, and the resulting personalised micro-environment an individual seeks to control- from lighting and temperature to security and entertainment.





Building automation systems help humans make better decisions through intelligent data behind the micro-environment...

1.2 The Integral Role of Display Solutions In Smart Buildings

Display solutions are not simply a secondary component in a smart building ecosystem, but they re-embed the human element into smart buildings. At the back end, the efficiency of automated data and the technology that drives it is unquestionable. At the front end is the resulting delivery of desired micro-environment in the building space that is enabled by the backend data and its associated technology.

But what is often overlooked in BAS deployment, particulary in the early stages of design, is the human and how we interact with the data that enables the micro-environment we first sought to attain. As important as all components of any BAS, is the ***bridge*** between the data and the resulting environment:**the smart display solutions and its technology**.

The deployment of a combination of sensors and smart display solutions provide building occupants with the right information at the right time, enabling them to be responsive to adjusting their environmental conditions, in as subtle and diverse a manner as one chooses. This embeds the human as the decision maker amidst the driving power of numerous automated sensors and data analytics found in smart buildings.

Display solutions are not a technology of the past, but in fact are part of the next generation of innovations linked to intelligence augmentation (IA). IA – the use of information technologies to increase human intelligence performance – is rapidly innovating the technology space in general, and smart buildings in particular.

With display solutions, information is presented to building occupants - human beings - in such a way that amplifies personalised choice that suits their needs. Whilst artificial intelligence (AI) takes away the laborious task of data analytics from humans and facilitates faster and more sophisticated process-driven decisions, intelligence augmentation (IA) on the other hand returns the human back to the centre of the equation, by embedding choice in a digitally automated ecosystem of smart buildings.

4D SYSTEMS has recognized this important interconnected-ness - of AI and IA – from the very start of the smart building revolution, and have consistently focused on designing display solutions that are smart in two ways :

(i) The technology that drives the display modules through our software and processors and its inteconnectivity to the rest of a complex BAS, and;
(ii) The aesthetics of the display with which the human interacts with data, right at our fingertips.

Any building automation must make Human Centred Design (HCD) a primary focus, and that is why 4D SYSTEMS designs its display solutions to help humans make better choices in an easy to use interface that is interconnected to complex data infrastructure.

2. REVERSE-ENGINEERING, ENGINEERING : PLACING HUMAN INTELLIGENCE AT THE CENTRE

2.1 Dubai International Airport : Artificial Intelligence Driven, Human Choices at the Centre

Ranked as the 3rd busiest airport globally, Dubai international airport (DBX) has undergone a major overhaul in the past 5 years, deploying one of the largest automation infrastructure projects in the world. One of the motivations for the automation infrastructure was the airport's bid to reduce operations costs and improve energy efficiency. Dubai International Airport partnered with Siemens and other partners to adopt and implement BAS in the airport's structure, operations, management, and control.

The entire airport's automation ranges from immigration processing, baggage handling, automated vehicles, and one of the largest projects- building automation of its micro-environment through lighting, temperature, passenger movement analytics, and passenger mood experience. These physical and digital technologies comprise variable frequency drives, panels, intelligent controls, energy metering, sensors and touch-screen panels. Among the most important elements of the entire artificial intelligence-driven automation system are the touch screen panels that control and allow for overriding automated decisions to suit the human choices within a heavily artificial intelligence-driven environment.

According to DBX authorities, touch panels provide "*.... simple navigation, the ability to set customised levels, and a fitting design aesthetic.*"

Whilst there are numerous benefits to the specific technology used in this world-class project, it is the micro-environment created, and automated decisions made possible through the sensors, touch screen panels, and multiple touchpoints that enhance passenger experience, helped cut down operational costs, and improve system reliability and energy efficiency.

The display panels convert automation into customisable experiences in a highly artificial intelligence-driven infra-structure. And at the core of DBX's choice, along with cutting -edge technology, is design aesthetics of the graphic user interface (GUI) and simple navigation within the display modules for humans to choose from data-driven information.

This very augmentation of technological intelligence-***placing human choice at the centre***-and doing so with aesthetic appeal is what 4D SYSTEMS excels in and offers innovative solutions for.

2.2 4D SYSTEMS Project Brief: The Sinclair, World's First All-Digital Hotel

In Fort Worth, Texas stands a building from the early 1900s. The original elevator doors and cigar boxes might fool one to think they have travelled back in time. It is anything but: from check-in to accessing your room, the hotel is futuristic and all digital.

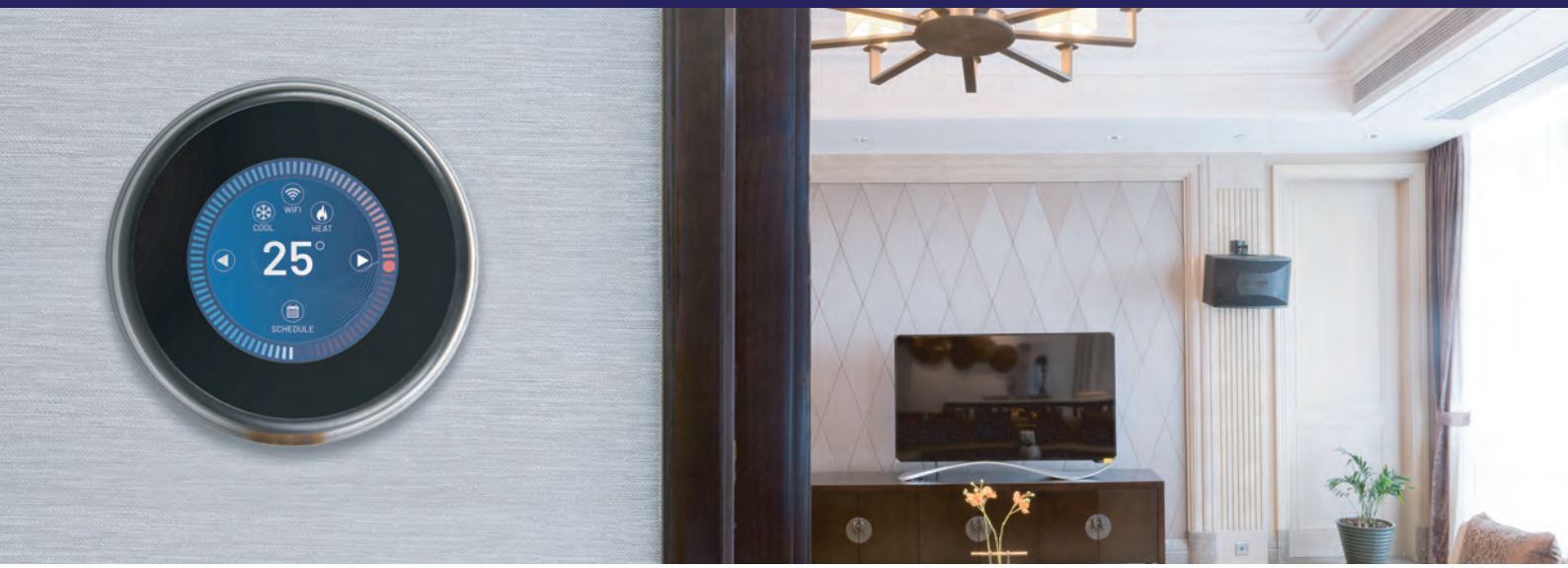
Sinclair hotel's management employed BAS, using IoT as a gateway to incorporate software components to automate and adjust lighting and temperature settings, improve energy efficiency, provide a variety of internal and external communication capabilities and send push notifications to guests in their rooms when needed with the goal to offer guests the best experience the moment they enter through the door.

The hotel has over 7000 endpoints that are connected using low-voltage Power over Ethernet (PoE) cables. These endpoints are a combination of sensors and rich display interfaces - including that from 4D Systems - which put the guests at the helm of decision making by providing them with needed data and access to entirely control the experience during their hotel stay; an excellent example of IA (intelligence augmentation) in hospitality.

Companies like Intel, Cisco, NuLEDS and Igor-Tech have their data and Internet of Things technology weaving everywhere behind the walls of the entire hotel. This quietly and seamlessly, helps share and utilise data that drives the digital technology of the world's first all-digital hotel. From the automated system that uses IoT to collect and analyse data, to the PoE low voltage cables to deliver electricity to power switches via ethernet cables. Furthermore, innovative display solutions provide guests with access to trending news, weather updates, music curation, and contact guest services that become integrated within the hotel's digital ecosystem.

All of these technologies provide a human-centric experience for the guests and allow data collected from multiple touchpoints to improve human choices, putting the guests at the helm of smarter decision-making using 4D System's **4Discovery display solution**. At multiple touchpoints powered by 4Discovery-50 intelligent display, Sinclair Hotel guests can customise environmental settings such as temperature, lighting, and shower preferences to create a personalised customer/user experience.

4D SYSTEMS customised its intelligent display module to meet The Sinclair's specifications, as well as to suit the project's partners like Intel, Cisco and Igor-Tech. At the centre of the guest's attention is the custom-designed 4Discovery smart display system from 4D SYSTEMS, whilst the sophisticated IoT, PoE and the entire automated digital infrastructure quietly and invisibly operates efficiently behind the scenes, contributing to immense energy savings for The Sinclair, thus creating a more sustainable and energy -efficient building.



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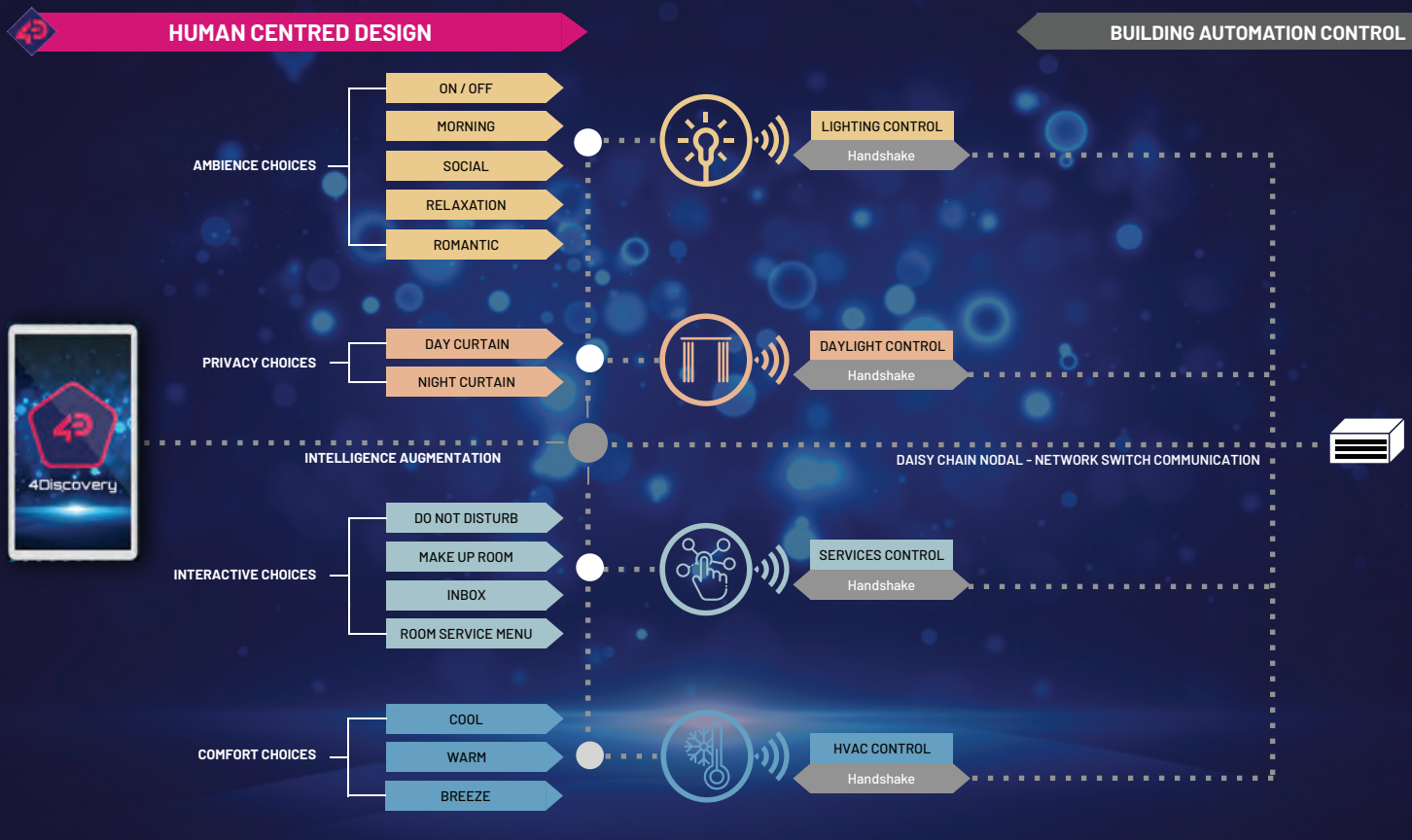
TYPICAL 4DISCOVERY SMART HOTEL SOLUTION



3. IN FOCUS: 4DISCOVERY & 4D SMART SOLUTIONS

Intelligence augmentation is at the centre of 4D SYSTEMS' Human Centred Design (HCD) for its display technology. As the name of the display module suggests - 4Discovery - it invites building occupants to discover the choices they have in regulating the micro-environment, whether it is a hotel room, office space, a residence or even retrofitted commercial spaces.

3.1 DISCOVER THE 4DISCOVERY SOLUTION

The 4Discovery's 2nd generation family of display modules are the 4Discovery-50 and the all new 4Discovery-13, with the continuing line of 1st generation 4Discovery-35.

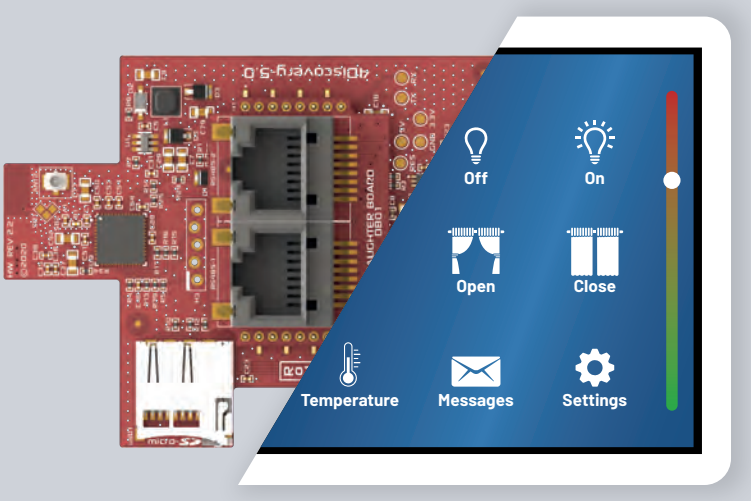
The 4Discovery family is a suite of intelligent wall-mounted display solutions that provide engineers, software and product developers with the capability to develop HCD display solutions for building automation systems that puts humans at the centre with variable choices right at their fingertips.

The Workshop4 IDE Software is a comprehensive, integrated software development platform that caters to the entire family of processors and modules, including the 4Discovery modules. The Workshop4 IDE employs a simple design flow to create the gen4-compatible graphics user interface in as simple a process as drag-and-drop. It supports 4 design environments that cater for different user requirements (and coding expertise) and comprises the Editor, Compiler, Linker and Downloader for a complete 4DGL application code development. Developers can write their own 4DGL code, utilise a visual programming IDE that allows drag-and-drop placement of objects, or integrate any desired display setup using pre-written code. From the novice to cutting-edge developers, the Workshop4 IDE offers the simplest and unparalleled ability to create GUIs limited only by their imagination.

The RS485 programmer completes the 4Discovery family. It is an essential hardware tool employed to program new firmware/PmmC, display drivers, customise and test the 4Discovery module, and move compiled Workshop4 Applications.

The 4Discovery-50 Display Solution

- Powerful 5.0" Intelligent TFT IPS display module, with 480x854 resolution & RGB 65K true to life colours
- Powered by 4D LABS' own DIABLO16 processor
- Full colour images, animations, icons & video files
- Easy access to microSD card for multimedia retrieval & updates
- GUI Design and Programming done in 4D Workshop4 IDE
- Customisable via 4Discovery-specific 485 programmer



- Integrated WiFi & bluetooth connectivity, & with integrated antenna plus connector for an external
- Integrated Proximity Sensor for activation of the device from sleep mode or other functions as programmed by the user
- Capacitive Touch Screen with wide viewing angles icon from all directions with FWVGA (Full Wide Video Graphics Array) & RGB 65K true to life colours
- Optional Flash Memory available for internal storage of multimedia, data files, fonts, or for holding extra code functions
- 2 x RJ45 jacks with RS485; can be used to form daisy-chain
- RoHS and CE Compliant

3.2 5 KEY BENEFITS OF THE 4DISCOVERY FAMILY

The 4Discovery family of products exhibits numerous advantageous features that set them apart from the competition. These key benefits include at least these five key advantages:

1. Open Protocols

At 4D Systems, we appreciate collaboration towards a common goal. That is why we have made the 4Discovery family an open protocol as opposed to using patented closed protocols.

We want to give engineers, software and product developers absolute control over what they can create using our range of 4Discovery products. This we have made possible with Workshop 4, our very own comprehensive integrated software development platform that caters to 4Discovery processors and modules.

2. Power Over Ethernet Devices Connectivity

Built into the 4Discovery family is the capability to connect to POE enabled drivers via our RS485 serial cable. As evident in our partnership with Sinclair Hotel and the use of the 4Discovery-50 intelligent wall-mounted display, POE saves cost by eliminating the need to create separate systems to cater to power and ethernet availability. This reduces the amount of required network configuration, and saving cost because POE is a low-voltage power option and provides administrators and users with comprehensive control over their smart building and automated ecosystem.

3. Quick Prototype Testing

One important factor that sets the 4Discovery family apart from the competition is our quick prototype testing. At 4D Systems, we acknowledge the hard work that goes into each product development. Hence with the 4Discovery family, you don't have to wait for so long to get feedback on your ideas.

You not only get quick feedback, but you also do it without breaking an arm and leg as opposed to what's obtainable with the competition. Hence, the time-to-market is significantly reduced, and products can be customised till they fully represent your projected idea.

4. Creative Aesthetics

Aesthetics influence how people think and feel about a product. As a result, the 4Discovery family provides a stylish product range that not only looks good but can also be customised to meet the architectural needs of its environment.

At 4D Systems, our goal is to create elegant and stylish yet functional display solutions that both product creators and users will admire and feel good about.

5. Exceptional Cost Control

The highlight of the combined four benefits listed above, is those crucial factors are achieved with enhanced cost effectiveness. The 4D SYSTEMS' hallmark for cost effectiveness is its modular design offerings for all of its solutions, as opposed to discrete design solutions that have start-up costs that will severely affect cashflow.

When analysing the cost of a design it is imperative to consider all of the associated resources, including design time, simulation time and tools, layout time, host PCB requirements, evaluation time and capital equipment costs, in addition to Bill Of Material cost alone. When projects are analysed from this more holistic level, the use of modular design framework enables projects to be delivered to production in a shorter amount of time, with less risk, and lower overall project costs. And 4D SYSTEMS helps deliver exceptional cost control and effectiveness for every solution it works with OEMs and commercial products with embedded display.

PRODUCT COMPARISON OF THE 4DISCOVERY SUITE

		4Discovery-50	4Discovery-35	4Discovery-13
DISPLAY	Size:	5.0"	3.5"	1.3"
	Resolution:	480 x 854	480 x 320	240 x 240
	Type:	TFT Screen with Capacitive Touch Panel	LCD-TFT Screen with Resistive Touch Panel	TFT Screen with Capacitive Touch Panel
	Capability:	Full colour images, animations, icons & video clips	Full colour images, animations, icons & video clips	Full colour images, animations & icons
	Viewing angle	Wide viewing angles from all directions	Check product datasheet for detailed guide	Wide viewing angles from all directions
INTERFACE	Processor:	DIABLO16 processor by 4D LABS	DIABLO16 processor by 4D LABS	PIXXI-28 processor by 4D LABS
	4D 485 programmer:	Yes	Yes	Yes
	Workshop4 IDE:	Yes	Yes	Yes
	microSD connector:	Yes	Yes	No
	Flash memory:	Optional	Optional	Yes
IoT	WiFi:	Yes	No	Optional
	Bluetooth:	Yes	No	No
	Proximity sensor:	Yes	No	No
UTILITY	Custom design capability:	Yes	Limited	Yes
	FAT16 File Format Access :	Yes	Yes	No
	Windows fonts available:	Yes	Yes	Yes
MEASURE	Module dimensions:	76.2 x 139.4 x 24.8mm	74.0 x 117.0 x 21.7mm	60.1 x 60.1 x 16.0mm
	Weight:	130g	80g	31g
	Display viewing area:	62.56 x 110.53mm	48.96 x 73.44mm	32.0mm diameter round
COMPLIANCE	RoHS:	Yes	Yes	Yes
	CE:[2]	Yes	Yes	Yes
	Flammability:	UL 94V-0	PCB: UL 94V-0	UL 94V-0

Choose from 4 development environments

based on your application requirements or even user skill level:

- Enables user to write 4DGL code to program display module
- 4DGL syntax very similar to C: no need to learn a new language
- 4DGL is optimized for GOLDELOX, PICASO, PIXXI and DIABLO Controllers

- Aptly named, a visual programming experience as you develop the display
- Enables drag and drop of objects in a WYSIWYG editor
- Software generates 4DGL code for the graphics

- An advanced environment; no 4DGL coding Required
- Everything is automated
- Drag and drop objects on the display and define events
- Code written automatically

- Transforms the module into a serial slave
- Control the module from any host microcontroller with a serial port
- All serial protocols and documentation are provided

WORKSHOP4 IDE

The integrated software development platform by 4D SYSTEMS

for all of the 4D family of processors and modules. The IDE combines the Editor, Compiler, Linker and Downloader to develop complete 4DGL application code. All user application code is developed within the Workshop4 IDE

GLOSSARY

Artificial Intelligence (AI) : computerised simulation of human intelligence processes, by machines that relieves humans having to undertake those processes and tasks. AI is often the foundation of automations and predictive systems.

Building Automation Systems (BAS) : technologies which are used to automate a building's predictive physical environment to control conditions for energy conservation, safety and security, work productivity, as well as customised micro-environment experience for the occupants. Sometimes also referred to as Building Automation Controls (BAC).

Digitally Automated Buildings : Buildings that utilise BAS, and often referred to as smart buildings.

Human Centred Design (HCD) : design and implementation of technology that is driven by an ethos to help humans make better choices in an easy-to-use interface that is interconnected to complex and automated digital infrastructure.

Intelligence Augmentation (IA) : The use of automation and artificial intelligence that uses information technologies to increase human intelligence performance. In other words, IA is the ability of AI systems that helps make human intelligence smarter that uses Human Centred Design ethos.

Internet of Things (IoT) : a digitalised network of physical objects – things - that are embedded with sensors, software, and other technologies for the purpose of connecting and exchanging data with other devices and systems over the internet.

Smart Display Solutions: touchscreen display modules, like 4Discovery from 4D SYSTEMS, that is a bridge between human initiated inputs through the touchscreen, that provide non-predictive and variable data to the BAS.

Smart Display Solutions: touchscreen display modules, like 4Discovery from 4D SYSTEMS, that is a bridge between human initiated inputs through the touchscreen, that provide non-predictive and variable data to the BAS.

REFERENCE NOTES

1. Source: https://b2b.hdl-automation.cz/cz/ke-stazeni/marketing/firemni-prezentace/reference-letiste-dubajn.

2. Undergoing EMC compliance.

QUICK LINKS

1. For information on 4Discovery products by 4D SYSTEMS, go to :
https://4dsystems.com.au/products/home-building-automation.

2. To read more about the Sinclair Hotel in Fort Knox, go to
https://4dsystems.com.au/blog/historic-hotel-in-fort-worth-texas-digitally-transformed-with-smart-display-solutions-from-austral ia/.

3. For more information and enquiries about how 4D SYSTEMS can assist with your building project to include smart display solutions send your enquiry to enterprise@4dsystems.com.au.

ABOUT 4D SYSTEMS

The Company

4D SYSTEMS Pty Ltd is a global leader in engineering solutions through robust research, development and manufacture of intelligent graphics solutions driven by creativity. Our compact and cost-effective intelligent display modules utilise the latest state-of-the-art OLED and LCD technologies with embedded custom graphics processors that deliver stand-alone functionality and eliminate low-level development requirements. Combined with our comprehensive software tools, our modules provide unrivalled ease-of-use and time-to-market for developing virtually any application requiring a graphical user interface with or without touch functionality.

Established in 1990, our extensive experience allows us to transform concepts and ideas into cutting-edge hardware and software solutions. Our engineering team consists of highly skilled and creative electronics and software engineers who work in close partnership with world-class production facilities. With ISO:9001 and ISO:14001 certified manufacturing facilities, we focus on delivering the highest level of quality and customer experience. We are headquartered in Sydney, Australia with one European office in Vienna, Austria, as well as representative offices in New Zealand, Malaysia, Philippines, Turkey and the UK. Our solutions are available globally through our extensive worldwide distribution network.

CORPORATE STANDARDS

To operate as a globally competent and respectable solutions provider, we are continuously adopting internationally recognised standards that help us deliver safer and better products that help our customers solve problems using our display solutions technology.

ISO 9001

We received our certification in 2019, and as an ISO 9001-certified company, our focus is to deliver highest level of quality through our production quality assurance process, delivering the consistency in all our products that our customers can rely on for design, production, delivery as well as support.

ISO 14001

From the earliest time of startup of 4D SYSTEMS, we have been an advocate for minimising waste in parallel with being environmentally responsible. In 2021 we will have attained ISO 14001 certification as a result of our commitment to holistic stewardship toward the environment.

ISO 13485

We take our quality management systems extremely seriously, and in 2021 we are investing in implementing ISO 13485 standards to meet Medical Device Directives, regulations and responsibilities as well as demonstrating our commitment to the safety and quality of our display solution for medical devices.

ISO 26000

Our 6-Article Ethos is already built on the foundations of ISO 26000; they together guide 4D SYSTEMS to engage in and contribute to social responsibility aligned with our mission, vision, as well as the beneficial interests of the environment and all of our stakeholders. Humane Capital is a key principle underlying our efforts to comply with and be recognised as an ISO 26000-certified enterprise from 2021 and beyond.

4D Philosophy for Excellence

The 4D Philosophy for Excellence is our continued commitment to design and manufacture the best solutions for our customers that meet the highest standards of quality, service and function.

And, we have developed a system to do exactly that: our internally developed framework for excellence is called THE AKNAR METHOD.

The AKNAR METHOD borrows inspiration from existent best practices that are contemporarily practised in the wider industry, to create a hybrid Philosophy that is unique to 4D SYSTEMS.

THE AKNAR METHOD

AGILITY (A)

- We are quick to analyse what provides optimal solutions & removes roadblocks to efficiency
- We are quick to shift to prioritise resources & efforts for best outcomes for our customers
- We evolve quickly towards better processes by adopting best improvement opportunities in keeping with our Vision

KNOWLEDGE (K)

- We make informed decisions that are based on data, rather than assumptions
- We embrace critical feedback as an opportunity to understand problems in order to solve them
- We develop knowledge resources that help us explore better production methods in line with our Purpose

RESPONSIBILITY (R)

- We utilise knowledge resources to make decisions that are as agile as they are lasting
- We minimise risks by having clear best practices that enable clarity of action
- We amplify our belief in our Purpose, Vision, Mission and Values by living them to our best ability

NETWORK (N)

- We develop long-term & balanced relationships with our suppliers that help amplify our Values
- We develop strategic alliances with our partners that help fulfill our Mission
- We nourish & respect both our workplace colleagues as well as our customers that help us to walk together the story of our Humane Cosmology

ADAPTABILITY (A)

- We utilise our agility & knowledge resources to adapt to disruptions as well as improvements
- We listen to & engage with our networks to learn, improve and adapt to the constant of change by maintaining high standards of quality in everything we do
- We embrace change without losing focus, and we explore ideas without delaying resolution of decisions

The AKNAR METHOD enables our organisation to go beyond systems that often narrowly focus on problem-solving & standardisation only. By being agile, knowledge-driven, network built on relationships, adaptable to change and resolute on decision-making, the 4D Philosophy for Excellence is brought to life in all departments of 4D SYSTEMS.

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