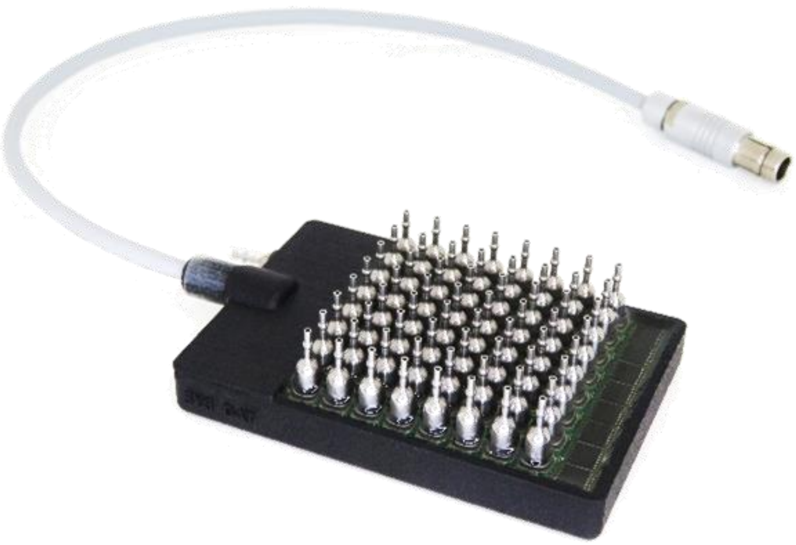
64-CHANNEL MINIATURE PRESSURE SCANNER SYSTEM

User Manual



WARNING

Read this document before using the product.

This system is not certified for use on aircraft.

Contents

Version Control

Version	Date	Summary of changes	Software release
1.0	10-2021	New document	1.0
1.1	10-21	Addition of IMU specification	1.0

1 INTRODUCTION

Principle of operation

The system consists of a 64-channel pressure scanner system and an optional communications module.

The system's power and communications may be via USB or 3.3V TTL, with CAN2.0B and Ethernet available via an additional communications module.

System description

Miniature multichannel pressure scanner system.

System components

1x Micro-scanner system	64-channel micro-scanner system with common static reference port
1x communications module	CAN2.0B processing module.
Accessories	Accessories including pressure cables and connectors are available and may have been included in the shipment.

Please ensure that all the system components listed above have been supplied, and that there is no apparent damage from shipping.

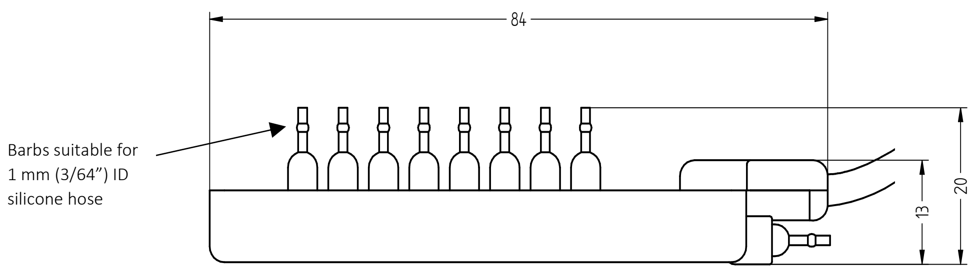
2 DETAILED SPECIFICATION

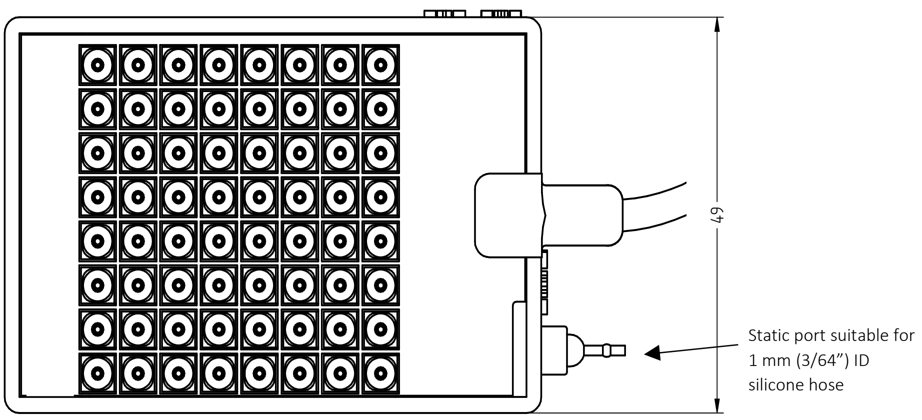
Specification

Connection	USB	CAN2B comms module
Pressure range	± 6.9 kPa FS	
Maximum overpressure	34 kPa	
Sensor repeatability[1]	± 0.024 % FS	
Sensor accuracy[2], inc. calibration	± 0.25 % FS	
Total error band after auto-zero[3]	± 1.25 % FS	
Operational mode	Differential	
Operating temperature range	-40° to +85° C non-condensing	
Compensated temperature range	0° to +50° C non-condensing	
Storage temperature range	-40° to +85° C	
Vibration	Sensors rated to 10 g, 10 Hz to 2 kHz	
Shock	50 g, 6 ms duration	
Maximum relative humidity	95 %	
IMU specification	3 axis gyro, 125 °/s FS, ± 3.9 x10-3 °/s 3 axis accelerometer, 2g FS, ± 0.061 mg	
Communications interface	USB via connector	CAN2B via comms module
Power	490 mW	720 mW (whole system)
Data acquisition rate	160 Hz max. Simultaneous sampling.	
Digital resolution	24-bit	16-bit

[1] Includes errors due to pressure non-linearity, pressure hysteresis and non-repeatability.
[2] Includes errors due to pressure non-linearity, pressure hysteresis, non-repeatability and calibration uncertainty.
[3] Total residual error after auto-zero, excluding residual temperature sensitivity.

Dimensions





3 COMMUNICATIONS

When the scanner is powered on, it will display a single green LED, then undergo a brief system diagnostic test; once this is complete a second green LED will illuminate. If there is a boot error, the second green LED will not illuminate.

The CAN2.0B communications module will display a single green LED if the system diagnostic test is passed, and a red error light if a CAN bus state error is present.

CAN2.0B Data Packet Formats

The CAN2.0B communications module comes pre-configured with a CAN Standard base ID of 0x0001, bus length of 1m, and baud rate of 500 kbps. Ensure that baseID, baseID+1 … baseID+16 are not occupied on the same CAN network.

Note these settings are configurable with access to the USB port on the CAN communications module, as detailed in section 6. User-configurable options are: base ID (0 to 0x07FF) (or to use an Extended base ID (0 to 0x1FFFFFFF)), baud rate (only 125, 250, 500, 800 kbps), CAN bus length, and address filtering and masking.

CAN data message 0 format. CAN ID = BaseID						
Byte no.	Value	Type	Description	Converted Unit	Additional Info.	Conversion Info.
0 1	P0	int16	Sensor 0	Pa	Little-Endian	P0 = int16_val * 6894.7573 / 32767.0
2 3	P1	int16	Sensor 1	Pa	Little-Endian	P1 = int16_val * 6894.7573 / 32767.0
4 5	P2	int16	Sensor 2	Pa	Little-Endian	P2 = int16_val * 6894.7573 / 32767.0
6 7	P3	int16	Sensor 3	Pa	Little-Endian	P3 = int16_val * 6894.7573 / 32767.0

CAN data message 1 format. CAN ID = BaseID + 1						
Byte no.	Value	Type	Description	Converted Unit	Additional Info.	Conversion Info.
0 1	P4	int16	Sensor 4	Pa	Little-Endian	P0 = int16_val * 6894.7573 / 32767.0
2 3	P5	int16	Sensor 5	Pa	Little-Endian	P1 = int16_val * 6894.7573 / 32767.0
4 5	P6	int16	Sensor 6	Pa	Little-Endian	P2 = int16_val * 6894.7573 / 32767.0
6 7	P7	int16	Sensor 7	Pa	Little-Endian	P3 = int16_val * 6894.7573 / 32767.0

… CAN data message 15 format. CAN ID = BaseID + 15						
Byte no.	Value	Type	Description	Converted Unit	Additional Info.	Conversion Info.
0 1	P60	int16	Sensor 61	Pa	Little-Endian	P4 = int16_val * 6894.7573 / 32767.0
2 3	P61	int16	Sensor 62	Pa	Little-Endian	P5 = int16_val * 6894.7573 / 32767.0
4 5	P62	int16	Sensor 63	Pa	Little-Endian	P6 = int16_val * 6894.7573 / 32767.0
6 7	P63	int16	Sensor 64	Pa	Little-Endian	P7 = int16_val * 6894.7573 / 32767.0

CAN data message 16 format. CAN ID = BaseID + 16						
Byte no.	Value	Type	Description	Converted Unit	Additional Info.	Conversion Info.
0 1	T_board	int16	Board temp.	°C	Little-Endian	T_board = int16_val * 0.01
2	P_status	uint8	Status byte	-	-	1 good, 0 bad (each sensor bit)
3	CRC_ok	uint8	CRC-16 flag	-	-	1 pass, 0 bad

IMPORTANT NOTE: Data are transmitted using the little-endian convention, so that the first byte transmitted for each quantity is the least significant.

Checksum & data corruption warning

A CRC-16 checksum word (uint16) is included at the end of each data packet to provide a warning of data loss or corruption in transmission. Example C++ code and DLL files to compute the CRC-16 checksum are available upon request. If the computed and transmitted checksums do not match, the entire data packet should be discarded.

Note that additional details about the system communications, including a summary of CRC-16-CCITT implementation, are appended to the end of this document.

4 PHYSICAL CONNECTIONS

Scanner

Pressure interface

The 64 pressure barbs plus 1 common reference barb are suitable for 1 mm/ 3/64” ID silicone air lines.

Signal interface

Power and communications to the scanner are via the comms module.

CAN2.0B communications module

This processor unit converts data into a CAN2.0B-compatible format. This includes truncation of the data from 24 to 16 bit, to optimise throughput and improve compatibility with other systems.

User Interface

The CAN2.0B module user interface is via a 4-way Molex Mizu-P25, 2.50 mm pitch waterproof wire-to-wire connector.

The system power supply V+ must be connected to a regulated DC supply (7 - 36 V, 12 V nominal). V+ is reverse-polarity protected.

PIN 1 is labelled on the connector and the pins are in order 1-4. The pin assignment is as follows:

Table 1: CAN2.0B comms module connector conductor assignment

PIN	Description
1	CANH
2	CANL
3	GND
4	V+

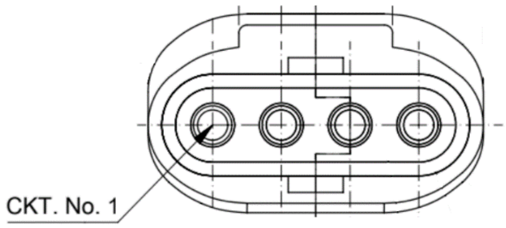


Figure 1: CAN2.0B comms module connector pin locations

5 CARE AND HANDLING

WARNING: Do not allow any conductive materials to come into contact with the system, or it may be permanently damaged.

- During fitting of silicone tubing to scanner and pressure sensor ports, ensure that no dust, dirt or liquid enters the lines. This will alter the system performance. Any foreign material introduced into the sensors themselves may permanently damage the sensors.
- Protect the sensors from moisture and dust, and store in an ESD-safe sleeve when not in service.
- Ensure that all electronic and pressure connections are appropriately strain-relieved.
- Do not use the pressure scanner system in wet or condensing conditions. Store in dry environment, or with desiccant pouch.

6 SOFTWARE AND DRIVERS

An executable is available for configuring the CAN2.0B module settings. Connect to the computer via the USB port on the module. To interface with a computer, the system requires 64-bit Windows 7 (or newer) operating system (not included).

Drivers

There are two external drivers which must be downloaded and installed on the computer in order for the PC to be able to interface with the system, in addition to the specific system driver.

- National Instruments LabView Run Time Engine (LVRTE)
- National Instruments VISA Run-Time Engine (NIVISA)

These drivers are freely available for download from National Instruments. Ensure that the 64-bit version of the Labview Run Time Engine is selected (note this is **not** the default option), and restart the computer following each installation.

Additionally, a further comms system install may be required for some older versions of Windows (not required for Windows 10).

Executable

After launching the software, you should see the window reproduced below (Figure 2).

1) Using the [COM PORT] drop down menu, select the appropriate COM port.
2) Before making changes, select “Get Config” under the [ACTIONS] menu.
3) Press the white run arrow to run software to read the current device configuration.
4) Ensure that there are no errors in the [ERROR] dialogue box. If an error has occurred at this stage, it is most likely an invalid COM port selection.
5) Make desired changes and select “Set config.” under [ACTIONS].
6) Press run to apply changes.
7) To verify successful application of settings, re-run the "Get Config" command.

Note the TTL baud rate should **not** be changed as this change cannot be successfully applied without also changing scanner settings (capability not yet implemented).

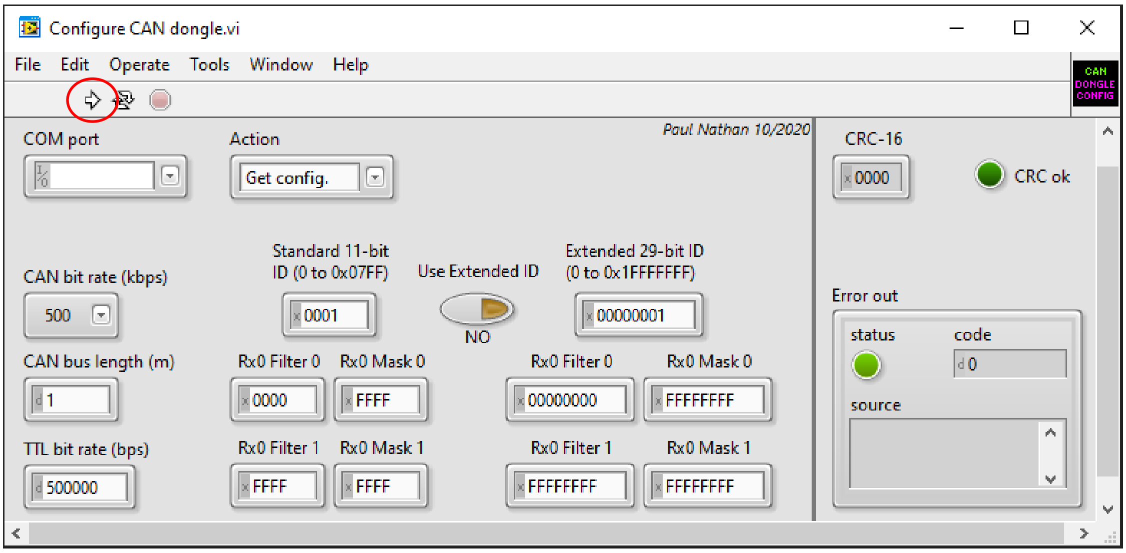


Figure 2: CAN system configuration software screenshot

7 TECHNICAL SUPPORT

Full technical support is available for this product and its associated software.

If you experience any difficulty in installation or use, or if you need additional support in the operation of the system, please contact your Surrey Sensors Ltd. account manager or technical representative.

Appendix: Additional communications details

Summary of CRC-16-CCITT Implementation in C++

Global Variables and Constants

```
uint16_t CRC16_LUT[256];
const uint16_t poly = 0x1021;
const uint16_t crc_init = 0xFFFF;
```

CRC-16 Lookup Table (LUT) Generation

The following function is called once at the start. The 1D array of length 256 “CRC16_LUT” is then stored in memory for all time and used whenever a CRC is computed.

```
void Generate_CRC16_LUT()
{
	for (uint16_t i = 0; i < 256; i++)
	{
		uint16_t Byte = i << 8;

		for (uint8_t Bit = 0; Bit < 8; Bit++)
		{
			if ((Byte & 0x8000) != 0)
			{
				Byte <<= 1;
				Byte ^= poly;
			}
			else
			{
				Byte <<= 1;
			}
		}

		CRC16_LUT[i] = Byte;
	}
}
```

Alternatively, the LUT can be hard-coded as a constant:

```
// CRC-16 lookup table for CCITT polynomial 0x1021

static const uint16_t CRC16_LUT[256] =
{
  0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50A5, 0x60C6, 0x70E7,
  0x8108, 0x9129, 0xA14A, 0xB16B, 0xC18C, 0xD1AD, 0xE1CE, 0xF1EF,
  0x1231, 0x0210, 0x3273, 0x2252, 0x52B5, 0x4294, 0x72F7, 0x62D6,
  0x9339, 0x8318, 0xB37B, 0xA35A, 0xD3BD, 0xC39C, 0xF3FF, 0xE3DE,
  0x2462, 0x3443, 0x0420, 0x1401, 0x64E6, 0x74C7, 0x44A4, 0x5485,
  0xA56A, 0xB54B, 0x8528, 0x9509, 0xE5EE, 0xF5CF, 0xC5AC, 0xD58D,
  0x3653, 0x2672, 0x1611, 0x0630, 0x76D7, 0x66F6, 0x5695, 0x46B4,
  0xB75B, 0xA77A, 0x9719, 0x8738, 0xF7DF, 0xE7FE, 0xD79D, 0xC7BC,
  0x48C4, 0x58E5, 0x6886, 0x78A7, 0x0840, 0x1861, 0x2802, 0x3823,
  0xC9CC, 0xD9ED, 0xE98E, 0xF9AF, 0x8948, 0x9969, 0xA90A, 0xB92B,
  0x5AF5, 0x4AD4, 0x7AB7, 0x6A96, 0x1A71, 0x0A50, 0x3A33, 0x2A12,
  0xDBFD, 0xCBDC, 0xFBBF, 0xEB9E, 0x9B79, 0x8B58, 0xBB3B, 0xAB1A,
  0x6CA6, 0x7C87, 0x4CE4, 0x5CC5, 0x2C22, 0x3C03, 0x0C60, 0x1C41,
  0xEDAE, 0xFD8F, 0xCDEC, 0xDDCD, 0xAD2A, 0xBD0B, 0x8D68, 0x9D49,
  0x7E97, 0x6EB6, 0x5ED5, 0x4EF4, 0x3E13, 0x2E32, 0x1E51, 0x0E70,
  0xFF9F, 0xEFBE, 0xDFDD, 0xCFFC, 0xBF1B, 0xAF3A, 0x9F59, 0x8F78,
  0x9188, 0x81A9, 0xB1CA, 0xA1EB, 0xD10C, 0xC12D, 0xF14E, 0xE16F,
  0x1080, 0x00A1, 0x30C2, 0x20E3, 0x5004, 0x4025, 0x7046, 0x6067,
  0x83B9, 0x9398, 0xA3FB, 0xB3DA, 0xC33D, 0xD31C, 0xE37F, 0xF35E,
  0x02B1, 0x1290, 0x22F3, 0x32D2, 0x4235, 0x5214, 0x6277, 0x7256,
  0xB5EA, 0xA5CB, 0x95A8, 0x8589, 0xF56E, 0xE54F, 0xD52C, 0xC50D,
  0x34E2, 0x24C3, 0x14A0, 0x0481, 0x7466, 0x6447, 0x5424, 0x4405,
  0xA7DB, 0xB7FA, 0x8799, 0x97B8, 0xE75F, 0xF77E, 0xC71D, 0xD73C,
  0x26D3, 0x36F2, 0x0691, 0x16B0, 0x6657, 0x7676, 0x4615, 0x5634,
  0xD94C, 0xC96D, 0xF90E, 0xE92F, 0x99C8, 0x89E9, 0xB98A, 0xA9AB,
  0x5844, 0x4865, 0x7806, 0x6827, 0x18C0, 0x08E1, 0x3882, 0x28A3,
  0xCB7D, 0xDB5C, 0xEB3F, 0xFB1E, 0x8BF9, 0x9BD8, 0xABBB, 0xBB9A,
  0x4A75, 0x5A54, 0x6A37, 0x7A16, 0x0AF1, 0x1AD0, 0x2AB3, 0x3A92,
  0xFD2E, 0xED0F, 0xDD6C, 0xCD4D, 0xBDAA, 0xAD8B, 0x9DE8, 0x8DC9,
  0x7C26, 0x6C07, 0x5C64, 0x4C45, 0x3CA2, 0x2C83, 0x1CE0, 0x0CC1,
  0xEF1F, 0xFF3E, 0xCF5D, 0xDF7C, 0xAF9B, 0xBFBA, 0x8FD9, 0x9FF8,
  0x6E17, 0x7E36, 0x4E55, 0x5E74, 0x2E93, 0x3EB2, 0x0ED1, 0x1EF0
};
```

CRC-16 Computation

The following function is called whenever a CRC-16 is required from an array of data.

```
uint16_t Calc_CRC16(uint8_t *Data, uint16_t DataLen, uint16_t crc)
{
	for (uint16_t i = 0; i < DataLen; i++)
	{
		uint8_t index = Data[i] ^ (crc >> 8);

		crc = CRC16_LUT[index] ^ (crc << 8);
	}

	return crc;
}
```

CRC-16 Function Call Example

The data for which the CRC is to be computed is first of all typecast into an array of unsigned char (uint8_t) “DataBytes”. This can be done using the `memcpy` function. When generating a CRC value for an array of data the length value “Len” passed to the function is that of the number of bytes in the entire array. However, when checking a CRC value appended to an array of data, the length value passed to the function is two less than that of the entire array so as to exclude the appended CRC word. The CRC value passed to the function is that of the initialiser constant “crc_init”, which, for the CCITT specification, is hexadecimal `0xFFFF`.

```
uint16_t CRC_computed = Calc_CRC16(&DataBytes, Len, crc_init);
```

Checksum Test

A checksum test is passed if the computed and transmitted checksum values are equal. With the CRC appended at the end of the transmitted data array the test is carried out as follows

```
uint16_t CRC_appended;

memcpy(&CRC_appended, &DataBytes[Len – 2], 2);

bool CRC_pass = (CRC_appended == CRC_computed);
```

Code implementation can be validated by cross-checking results with a reputable online CRC calculator such as https://crccalc.com/

CRC-16-CCITT Algorithm Parameters:

Polynomial divisor:	0x1021	$(x^{16}+x^{12}+x^{5}+1)$
CRC initialiser:	0xFFFF	
Input reflection:	False	
Output reflection:	False	
Output XOR:	0x0000	