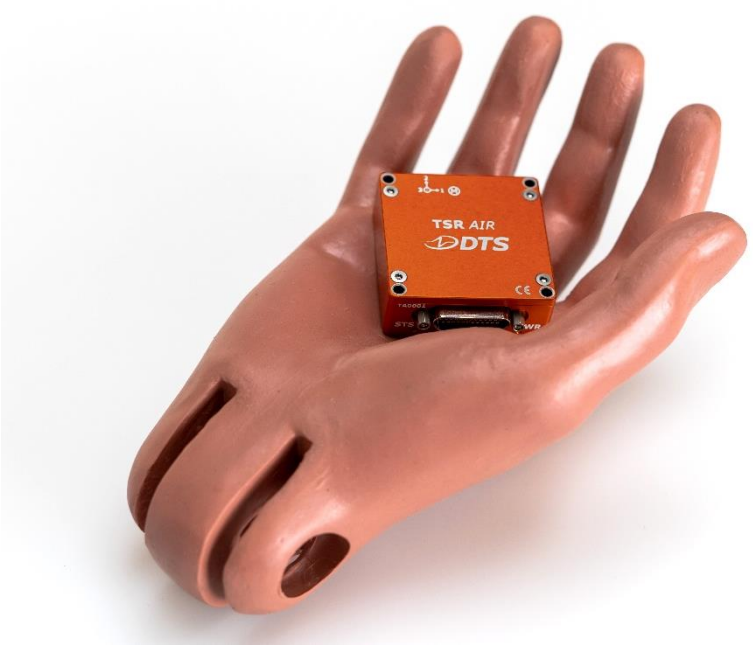
TSR AIR
User's Manual



February 2025

13000-60401-MAN (Rev. 6)

Contents

DTS Support

TSR AIR systems are designed to be reliable and simple to operate. Should you need assistance, DTS has support engineers worldwide with extensive product knowledge and crash test experience to help via telephone, e-mail or on-site visits.

The best way to contact a DTS support engineer is to submit a request through the DTS Help Center web portal (support.dtsweb.com). You must be registered (support.dtsweb.com/registration) to submit a request (https://support.dtsweb.com/hc/en-us/requests/new). Registration also enables access to additional self-help resources and non-public support information.

This manual supports the following products:

13000-60401: TSR AIR (8 GB)
13000-60402: TSR AIR (16 GB; on-board recording without streaming)
13000-60404: TSR AIR (16 GB; on-board recording with streaming)

Introducing the TSR AIR

The TSR AIR is a small, high-performance, low power, data logger that can autonomously recognize and capture long and short duration events via built-in sensors. The primary use for the TSR AIR is to collect data in various scenarios while mounted to the interior or exterior of a test article. Captured events can be started by crossing sensor thresholds, or by an external trigger. The device can also collect events based on a date and time or time interval. The device will stay in a low power state when not in use. The units can be daisy chained to share DTS bus signals and synchronization information.

- Shock rated to 500 g for dynamic testing environments.
- Sample rates up to 20,000 sps on 18 channels simultaneously (record in place or data streaming).
- Real-time data streaming up to 20,000 sps per channel.
- 3 channels of low g acceleration, 3 channels of high g acceleration, 3 channels of angular rate, temperature and pressure.
- Ethernet PTPv2 communications (IEEE 1588) easily supports synchronization of hundreds of channels.
- Optional time source synchronization using IRIG-B122 and GPS standards.
- LED indicators for system and power status.

See Appendix A for mechanical specifications, connector information and pin assignments. Appendix B discusses the network parameters of your equipment. A quick-start guide is available on the Help Center here.

Embedded Sensors

The TSR AIR contains independent embedded sensors for low g acceleration, high g acceleration, angular rate, temperature and pressure.

Sensor Sample Rates

The sample clocks on the embedded sensors collect data at their native rates. The TSR AIR then sub- or super-samples that data to match the TSR AIR system rate when storing in flash memory. At a given rate, each individual 3-axis sensor will record at its own independent rate. For example, with the TSR AIR set to sample at 10,000 sps, the low g sensor will

record at 25,600 sps, the high g sensor will record at 5,120 sps, and the ARS will record at 6,400 sps. See the table below for more details.

Sample Rate (SPS)	Low G (SPS)	High G (SPS)	ARS (SPS)
100	25,600	N/A*	100
500	25,600	N/A*	400
1,000	25,600	5120	800
5,000	25,600	5120	6400
10,000	25,600	5120	6400
15,000	25,600	5120	6400
20,000	25,600	5120	6400

* No data captured for this sensor at this rate.

NOTE: The temperature and pressure sensors are collected at 1 sps independent of the TSR AIR system sample rate. This data is super-sampled to the system rate in collected data.

Sensor Bandwidths

Like the sample rate considerations in the section above, each individual embedded sensor has its own bandwidth configuration at a given TSR AIR system sample rate. For example, with the TSR AIR set to sample at 10,000 sps, the low g sensor will have a bandwidth of 1 kHz, the high g sensor will have a bandwidth of 640 Hz, and the ARS will have a bandwidth of 178 Hz. See the table below for more details.

Sample Rate (SPS)	Low G (Hz)*	High G (AAF Hz)	ARS (Hz)*
100	10	N/A**	10
500	50	N/A**	38
1,000	100	160	75
5,000	500	640	178
10,000	1,000	640	178
15,000	1,500	640	178
20,000	2,000	640	178

* Post-ADC filter Hz.
** No data captured for this sensor at this rate.

Sensor Ranges

Each embedded sensor has its own measurement range capability.

Low G Acceleration

Can be configured to collect data at a range of 50 g, 25 g, 12 g and 6 g.

High G Acceleration

Can collect data at a range of 400 g.

Angular Rate Sensor (ARS)

Can be configured to collect data at a range of 2,000 deg/s or 250 deg/s.

System Connector

All communications, control signals and input power are provided via the 25-pin, micro-D system connector. Using a TSR AIR Chain Module or other interface, multiple units can be connected (daisy-chained) for hundreds of test channels.

Ethernet signals must be connected in series with a maximum cable length of ~10 m. (Cable quality may affect maximum length and performance.) Control signals must be connected in parallel. See Appendix A for pin assignments.

Time Synchronization

System-wide, channel-to-channel, time source synchronization is supported using Ethernet Precision Timing Protocol version 2 (PTPv2) communications (IEEE 1588), IRIG-B122, and GPS. PTP provides standards for precision clock synchronization for measurement and control systems via Ethernet network communications. Timing information is extracted from the network's master clock and used by the TSR AIR to adjust their internal (local) clock, providing precision timing for high channel-count systems with a sampling synchronization better than 10 µs. Communication is enabled after the initialization sequence has completed (~15 seconds after sufficient power and ON signal is applied). (Note network congestion may slow IP address acquisition.)

Power Management

A good power source is of paramount importance. The TSR AIR should be powered from a high-quality power supply.

Input Voltage	Idle	Ethernet Connected	Armed and Recording
9-30 VDC	<1 W	+0.1 W	<1.9 W

The TSR AIR does contain an internal rechargeable Li-ion battery. Without external power applied, the TSR AIR is in a hibernate state when not armed. When the unit is on (sufficient power and ON signal applied), power consumption depends largely on whether the unit is armed.

Battery

The TSR AIR contains a rechargeable, 350 mAh Li-ion battery. Battery performance is dependent on its recording state. Please refer to the table below for details.

	Arm State (mA)			
Recording Mode	**Hibernate**	**Idle Armed**	**Motion Armed**	**Recording**
Active	0.013	0.9		20.0
Active (pre-trigger)		7.0		
Active (motion)		0.4	0.9	
Active (motion + pre-trigger)		0.4	7.0	
Active (event to start)		0.4		
Scheduled		0.4		
Scheduled (interval recording)		0.4		
Streaming				

All recording modes use 20 mA when recording data. With input power removed, the TSR AIR can operate in the recording state for 17.5 hours with a fully charged battery.

$$\frac{\text{Battery Charge (mAh)}}{\text{TSR AIR Current Draw (mA)}} = \text{Hours of operation}$$

Example: Determine the time available in Idle Arm prior to a scheduled 10 hour recording:

$$\frac{350\ \text{mAh} - (20\ \text{mA} * 10\ \text{hours})}{0.4\ \text{mA}} = 375\ \text{hours (15.6 days)}$$

Example: Determine the time available in Idle Arm assuming the TSR AIR will see 50, 3 second events in Active (event to start) mode:

$$\frac{350\ \text{mAh} - (20\ \text{mA} * 50 * 3 / 60 / 60)}{0.4\ \text{mA}} = 872.9\ \text{hours (36.3 days)}$$

Power-up and Power-down Procedures

When sufficient power is applied, the TSR AIR will reboot (on, idle and communication enabled) if an ON signal is present. With power applied but the ON signal absent, the unit is in an idle state. Power up (ON state) occurs in ~15 seconds, after which communication is enabled.

Power down of the unit is immediate upon removal of either the ON signal or external power. Wait ~30 seconds before reinitialization.

LEDs

The TSR AIR has two LED indicators that show system and power status.

Status (STS) Indicator

	**Result**
Power up	
Communicating with PC	
Armed	
Unit received Event	
Idle -or- Armed without input power	

- At power up, the LED cycles from red to green to blue followed immediately by the power LED boot-up sequence.
- When not armed, the LED will blink green when handling a command from the PC.
- For Active mode:
  - When armed, the LED will go solid blue to indicate that it is waiting for an EVENT signal or level trigger to occur.
  - When the EVENT signal is received, the LED will turn red to indicate that it is actively recording data.
  - The LED will turn off when data collection has completed.

Power (PWR) Indicator

	**Result**
Power up	
Connected to host	
Power up; not connected to host	
Power fault (input power out of range)	
Armed (no input power)	 (once every 60 s)
Charging	 (once every 1 s)

- At power up, the LED cycles from red to green to blue immediately after the status LED has completed its boot-up sequence.
- When connected to host, the LED will turn blue.
- At power up but not connected to host, the LED will turn green.
- When input power is too high or too low, the LED will turn red.

Data Memory Size

With either 8 GB or 16 GB of flash memory available for data storage, the TSR AIR can record ~185 minutes or ~370 minutes of data, respectively, at the maximum sampling rate (18 channels at 20,000 sps). Given the large recording capacity, it is generally best to limit sampling rates and event durations to the minimum necessary to avoid large and cumbersome data files. Large files take longer to download and may also be time-consuming to post-process or difficult to share. Use of the Region of Interest (ROI) download can save a great deal of time if implemented properly.

Sampling Rates

User-selectable sampling rates are available from 100 sps to 20,000 sps.

# of Channels*	Maximum Sampling Rate (per channel)
18	20,000 sps

* All channels are recorded even if they are not programmed.

With 8 GB or 16 GB available for data storage, there are 4,000 M samples or 8,000 M samples available (1 sample = 2 bytes), respectively. To determine the maximum recording time, divide the number of samples by the product of the sampling rate and the number of channels.

$$\frac{4{,}000{,}000{,}000}{\text{Sampling rate (sps)} \ * \ \text{number of channels}} = \text{\# of seconds}$$

Example: 18 channels of data at 20,000 sps with 8 GB of memory:

$$\frac{4{,}000{,}000{,}000}{20{,}000 \ * \ 18} = 11{,}111 \text{ seconds (185 minutes)}$$

Example: 18 channels of data at 20,000 sps with 16 GB of memory:

$$\frac{8{,}000{,}000{,}000}{20{,}000 \ * \ 18} = 22{,}222 \text{ seconds (370 minutes)}$$

Basic Care and Handling

TSR AIR systems are precision devices designed to operate reliably in dynamic testing environments. Though resistant to many environmental conditions, care should be taken not to subject the units to harsh chemicals, submerge it in water, or drop it onto any hard surface.

Caution	
	Electronic equipment dropped from desk height onto a solid floor may experience up to 10,000 g. Under these conditions, damage to the exterior and/or interior of the unit is likely.

Your TSR AIR module is supplied with calibration data from the factory. DTS recommends annual recalibration to ensure that the unit is performing within factory specifications. The TSR AIR is not user-serviceable and should be returned to the factory for service or repair.

Shock Rating

The TSR AIR is rated for 500 g, 4 ms half-sine duration, in all axes.

Mounting Considerations

TSR AIR equipment should be bolted securely to the test article or dynamic testing device to provide the best shock protection. Mounting methods and hardware selection should be calculated to withstand expected shock loading and facilitate proper grounding. Check bolt tightness periodically to ensure that the unit is securely fastened to the testing platform.

DTS strongly recommends that all equipment be properly grounded to minimize any risk of data noise due to high-current transients. The test article or dynamic testing device should be connected to earth ground. TSR AIR equipment should be grounded to each other and bolted to the test article. DTS recommends checking continuity between the enclosures of each unit to confirm resistance readings of <1 ohm.

Thermal Considerations

The TSR AIR is a low power device with an operating temperature of -40 to 60°C. It is unlikely that self-heating will be an issue in real-world testing if proper mounting methods are observed. Never mount the unit to a thermally non-conductive surface like wood or plastic. ALWAYS use the TSR AIR with a heat sink if you are not mounting the system to a structure that will serve this purpose. Should you have any questions about using the TSR AIR in your environment, please contact DTS.

Temperature Sensor Accuracy

The highest degree of accuracy (±1°C when operating between 0-60°C) occurs when the unit is mounted to a substantial heat sink.

Pressure Sensor Accuracy

+/-1 hPa when operating between 300 hPa and 1100 hPa at 0°C to 65°C.

Environmental Rating

The TSR AIR is IP67 rated.

- 6 (solid ingress) = totally protected against dust.
- 7 (liquid ingress) = Protected against the effects of temporary immersion between 15 cm and 1 m.
  Duration of test: 30 minutes.

Care should be taken to prevent prolonged exposure to any potentially harmful environment. Units should be cleaned, dried, and inspected after exposure to any environment that could cause damage.

Software

DataPRO software is used with the TSR AIR. PC specifications are:

- Windows 10 and later (64-bit versions are supported)
- Microsoft .NET Runtime version 4.5.2
- i5 processor minimum; i7 processor recommended
- 8 GB RAM minimum; 16 GB RAM recommended (more RAM is important for high channel counts and longer/higher sample rates)
- 1 GB disk space for software plus additional storage for test data
- 1366 x 768 minimum screen resolution; 1920 x 1080 recommended

Additionally, DTS recommends a network that supports gigabit Ethernet (GbE).

A quick-start guide is available on the Help Center here.

Data Collection Concepts

The discussion below provides a general introduction to data collection. Please see the software manual for a detailed discussion and implementation specifics.

The TSR AIR is a standalone data logger. Once the system is armed, the PC can be disconnected if desired. After receiving an event signal, level trigger, or scheduled/interval event, the TSR AIR autonomously collects data, storing it to flash memory with no user interaction. After the test, the user reconnects the PC to download the data.

There is also a real-time mode in the control software that allows the user to check channel inputs on an oscilloscope-looking screen. (This data can be logged.)

Data Collection Modes

The TSR AIR supports two data collection modes: Active and Scheduled. (Note: The software cannot simultaneously display the data while the system is recording.)

Active Mode

Using this mode, the user can program the TSR AIR to record pre- and post-event data. Time Zero (T=0) is marked when the event signal is received. The maximum pre-event data is 0.0512 seconds. There are three options for this mode:

- Level triggers: Only available when "start record with event line" is not used.
- Start record with event line: Pre-event data not available with this option. This is the lowest power option.
- Wake up with motion: The TSR AIR will wake up when sensing motion.

Scheduled Mode

Using this mode, the user can program the TSR AIR to record at a scheduled time (UTC) or interval (in minutes). Interval counter starts count at scheduled recording time. (Interval length must be more than event length plus 30 seconds.) Pre-event data is not available when using this mode.

Examples:

- Start record scheduled at 1:00 AM for 10 seconds with an interval of 1 minute.
  - The first record starts at 1:00 AM, second record starts at 1:01 AM, third starts at 1:03 AM.

- Start record scheduled at 1:00 AM for 40 seconds with an interval of 2 minutes.
  - The first record starts at 1:00 AM, second record starts at 1:02 AM, third starts at 1:04 AM.

Note	
	An event or trigger signal applied anywhere in the TSR AIR chain is distributed throughout the chain.

Data Streaming (some models)

Real-time data streaming up to 20,000 sps is supported via DataPRO. IRIG-106 Chapter 10 is also supported, however third-party, IRIG-106 Chapter 10 compliant software is required for real-time visualization. Please see the DataPRO software manual for additional information, including how to create a test set-up.

Start Record and Event Initiation

The TSR AIR supports multiple methods of initiating event signals. Typically, event signals are initiated via an external hardware interface that provides a discrete contact closure (CC) signal to mark T=0.

All TSR AIR data collection modes support multi-event arming. A unit armed in a multiple-event mode will re-arm when an event completes. The unit will stop re-arming when the number of events specified by the user has been recorded or a disarm command is issued to the device.

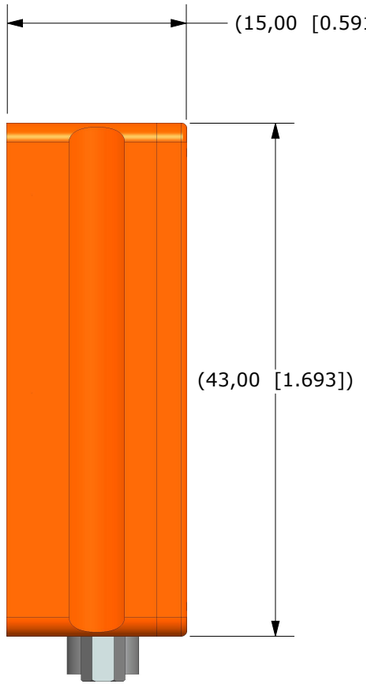
Additionally, Active mode supports level triggering. This method continuously samples the incoming data and begins data collection if the data is above or below predefined levels. For example, it might be useful to begin data collection when a certain accelerometer experiences a force above 200 g. Using level trigger and Active mode, the TSR AIR can support this or any level-trigger signal on the high g channels only.

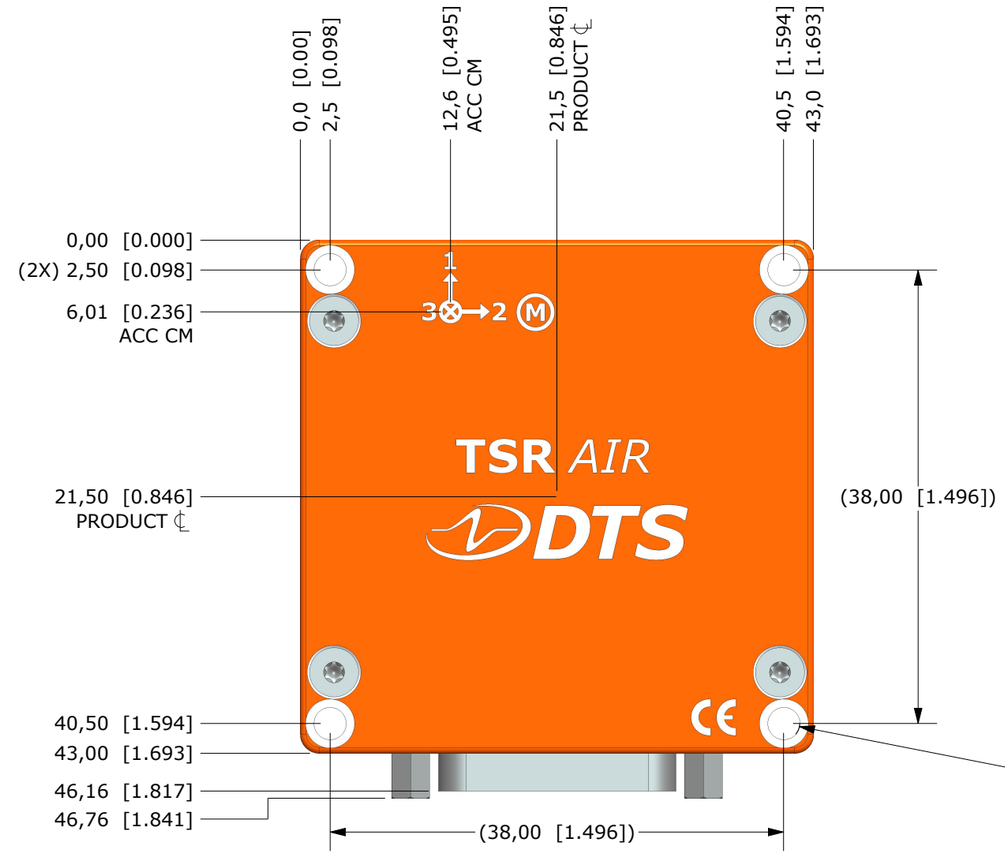
Caution	
	Level trigger is NOT recommended when the TSR AIR is used for destructive testing.

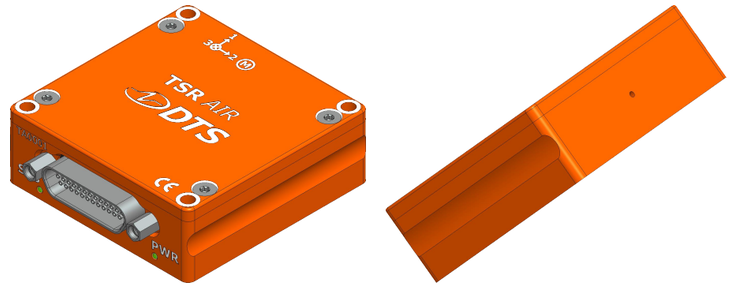
Finally, if the TSR AIR remains connected to the PC during data collection, the control software can be used to initiate data collection.

RoHS
Manufacture/fabricate to meet the EU RoHS Directive 2011/65/EU and RoHS Annex II phthalates

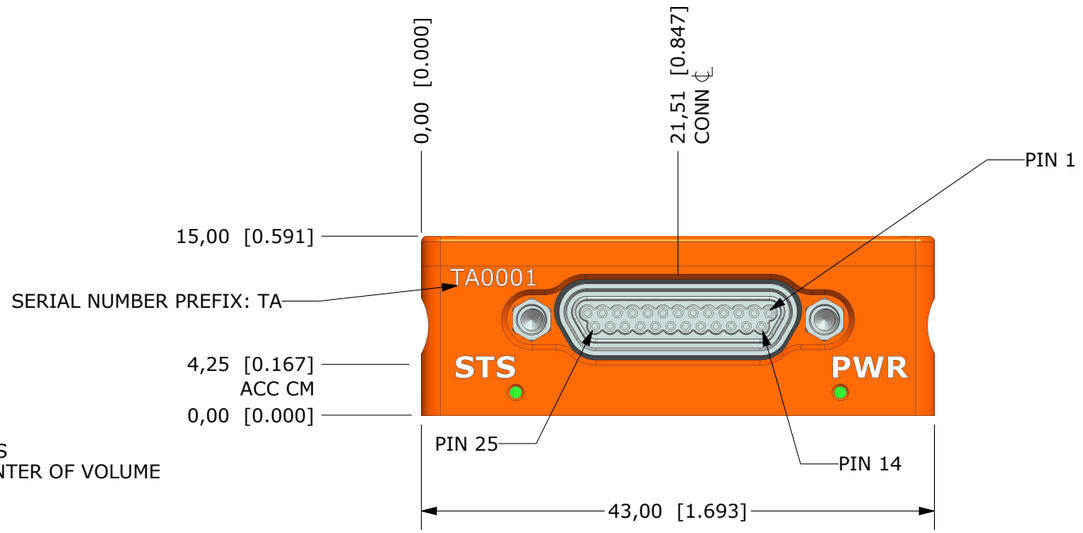
REV	ZONE	DESCRIPTION	DATE	BY
0		ORIGINAL RELEASE	2021-08-30	AH
1		UPDATED ARTWORK	2022-05-12	AH







SCALE 1:1



PIN	SIGNAL
1	+PWR
2	+PWR
3	+PWR
4	GND
5	GND
6	TX_2_P
7	TX_2_N
8	RX_2_P
9	RX_2_N
10	TX_1_P
11	TX_1_N
12	RX_1_P
13	RX_1_N
14	#ON
15	#START
16	#EVENT
17	STATUS
18	UART_RX_P
19	UART_RX_N
20	UART_TX_P
21	UART_TX_N
22	GND
23	GND
24	IRIGB
25	PPS

NOTES:
1) ACC CM = ACCELEROMETER CENTER OF MASS
2) TSR AIR MASS CG IS APPROXIMATELY AT CENTER OF VOLUME
3) MOUNT USING (4X) M2.5 SCREWS
4) TORQUE TO 3.7 IN-LB CLEAN AND DRY
5) CONNECTOR: OMNETICS P/N A99108-025
6) MASS: 45 ± 5g

DTS
SEAL BEACH, CA 90740
562-493-0158
www.dtsweb.com

MATERIAL: 6061-T6 ALUMINUM W/ INTERNATIONAL ORANGE ANODIZE

UNLESS OTHERWISE SPECIFIED:
UNITS = MM [INCH]
DIMENSIONAL TOLERANCES ±.254 [0.010"]
INTERPRET PER ASME Y14.5. DO NOT SCALE.

DESCRIPTION: TSR AIR, MOUNTING DRAWING
DTS P/N: 13000-604XX
REV: 1
DRAWN: A HAMDAN
DATE: 2021-08-30
SIZE: B
SCALE: 1:1
SHEET: 1 OF 1

MDL: TSR_AIR-ASM

Ethernet Chaining

To share Ethernet communications, chain TSR AIR units together using the methodology in the table below.

TSR AIR #1		TSR AIR #2		TSR AIR #3	
Function	**Pin**	**Function**	**Pin**	**Function**	**Pin**
		TX_2_P	6	RX_1_P	12
		TX_2_N	7	RX_1_N	13
		RX_2_P	8	TX_1_P	10
		RX_2_N	9	TX_1_N	11
TX_2_P	6	RX_1_P	12		
TX_2_N	7	RX_1_N	13		
RX_2_P	8	TX_1_P	10		
RX_2_N	9	TX_1_N	11		

Accessories/Support Equipment

13006-90460: SLICE6 AIR/TSR AIR Chain Module[1]
13000-30541: Power supply; 12 VDC, 2.5 A (90-240 VAC in, Molex term)
13000-31490: Cable, SLICE EOC Interface to TSR AIR SYSTEM port (Micro-D 25)
13000-60500: TSR AIR End-of-Chain Device Cable Kit
13000-60501: SLICE6 AIR DAS/TSR AIR Test Device Cable Kit
13000-60530: Cable, 2 TSR AIR daisy chain (2 ft) to EOC (1.5 ft)
13006-90820: Cable, 2 TSR AIR daisy chain (6") to SYSTEM pigtails (18")
13006-90840: SLICE6 AIR DAS/TSR AIR Test Device

[1] To connect individual chain modules (P/N 13006-90460) to each other, the standoffs on the socket side must be removed. Retain the screws for future use.

Appendix B: Hardware Configuration Specifications

The TSR AIR is typically delivered with a default IP address as follows:

IP address	192.168.6.**xx** where **xx** is based on the last two digits of the S/N; for example: S/N TA00**47** = 192.168.6.**47** S/N TA02**33** = 192.168.6.**33**
Netmask	255.255.248.0

The calibration data for your equipment identifies the IP address as shipped from the factory. If the calibration data is not available, try using the default address described in the table above.

If you need information on the specifics of your equipment, please submit a request through the DTS Help Center web portal (support.dtsweb.com) and include the serial number(s) of the equipment and parameters you are asking about.

Using the SLICE Network Configuration Utility

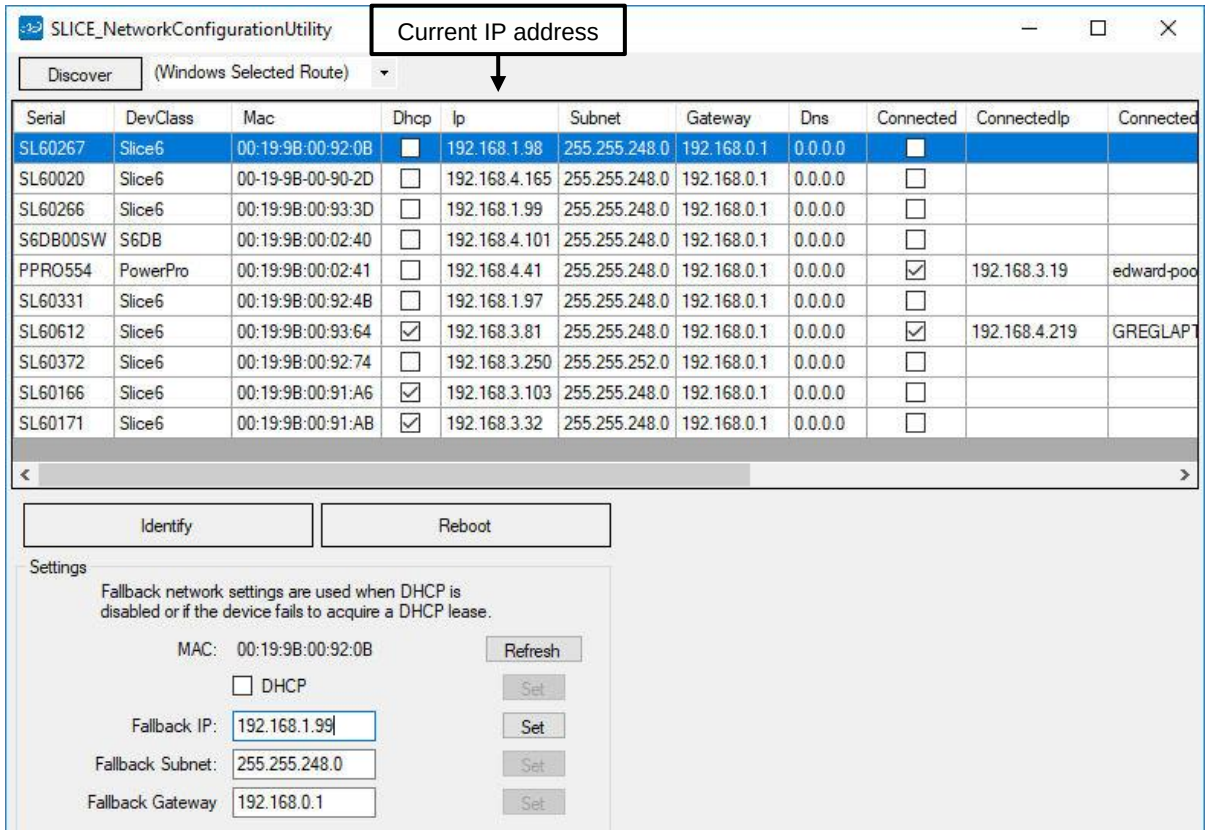
The *SLICE Network Configuration Utility* (available from the DTS Help Center) can be used to view or change the unit's IP address.

Use of the utility requires a network that supports multicast and the workstation running the utility must also allow it. Confirm that:

- The PC's Ethernet properties are not using anything that can block multicast; e.g., *DNE LightWeight Filter*.
- The Windows Firewall will allow multicast traffic.
- Any third-party anti-virus software will allow multicast traffic.

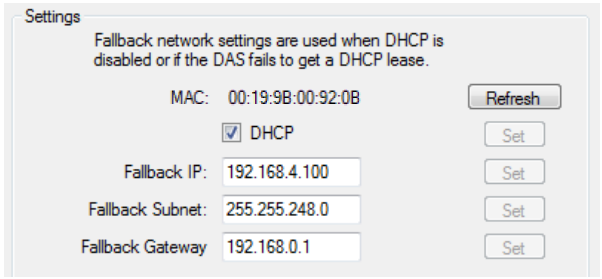
1. Open the *SLICE Network Configuration Utility*.

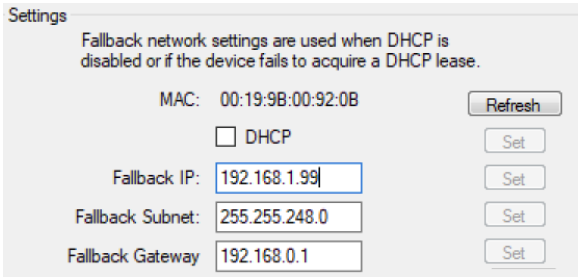
2. The software will immediately look for all attached devices and list them in the table. (You may also click Discover to refresh the list.)



Note: Clicking on Identify for any selected device will cause the unit's LED to flash.

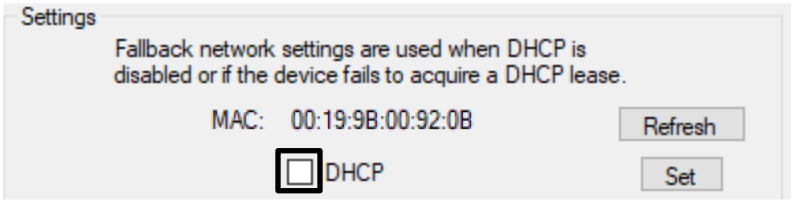
3. Select the TSR AIR device from the list. The device Settings are shown at the bottom of the window. The current IP address may or may not match the fallback IP address, depending on whether DHCP is selected.



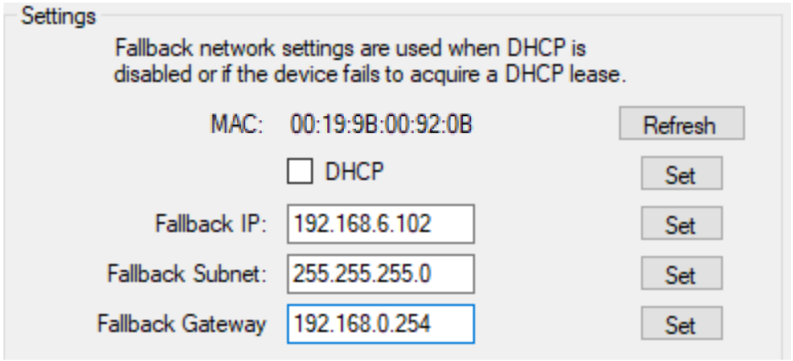


4. To enable DHCP, select the check box then select Set . Proceed to step 7.

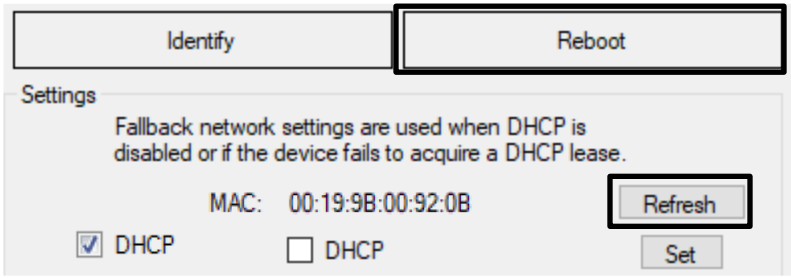
5. To disable DHCP and manually enter IP address and other information, unselect the check box.



6. Enter the new parameters and select Set for each item updated. (Note: The MAC address is not user configurable.)



7. Select Refresh to view the settings (optional), then Reboot the device.



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www.dtsweb.com

DECLARATION OF CE CONFORMITY

Description	Model
Data Logger	TSR AIR

The undersigned hereby declares that the products listed above, manufactured by Diversified Technical Systems, Inc., Seal Beach, California, USA, conform to the following directive and standards:

Applicable Council Directive: **89/336/EEC – Electromagnetic Compatibility**

Applicable Harmonized Standards: **EN 55022:1998, EN 55024:1998**

Rollin White
Head of DTS, Senior Director

March 13, 2023
Date

Revision History

Rev	Date	By	Description
0	13 Mar 2023	C. Balogh	Initial DRAFT.
1	21 Mar 2023	T. Ralston	Updated battery table to include current draw while armed.
2	27 Apr 2023	C. Balogh	Added equation to calculate recording duration given battery charge and current draw.
3	17 May 2023	C. Balogh	Added Note to table, bottom of page 5.
4	7 July 2023 7 Aug 2023	C. Balogh/ E. Kippen	Updated "Data Memory Size" section calculations to include 18 ch (was 12 ch). Added temperature and pressure sensor accuracy specs. Updated default IP address (was 192.168.4.xx).
5	10 Apr 2024	E. KIppen	Updated Timing Synchronization section. Clarified IRIG-106 Ch 10 requirements. Updated document format.
6	19 Feb 2025	E. Kippen	Corrected pressure sensor accuracy. Added details to Scheduled Mode.