

A Higher Level of Performance



Manual

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**G1**

## Microwave Switch Series

Beam Blockage Detection

**Circular Polarisation**



For more information, please visit >

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## G1 Microwave Switch Series



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#### PROPRIETARY NOTICE

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#### WARNING

This instrument contains electronic components that are susceptible to damage by static electricity. Proper handling procedures must be observed during the removal, installation, or handling of internal circuit boards or devices:

#### Handling Procedure:

1. Power to unit must be removed prior to commencement of any work.
2. Personnel must be grounded, via wrist strap or other safe, suitable means, before any printed circuit board or other internal devices are installed, removed or adjusted.
3. Printed circuit boards must be transported in a conductive bag or other conductive container. Boards must not be removed from protective container until the immediate time of installation. Removed boards must be placed immediately in a protective container for transport, storage, or return to factory.

# Overview

## G1 Microwave Switch Series



### Principle of Operation

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A high power circular polarized Microwave pulse is emitted from the Sending unit to the Receiving unit in a transmission chain of approximately 100 pulses per second.

If the path between the Sender and Receiver is blocked by any object or material which absorbs or reflects microwave energy the Receiving unit will no longer detect the complete transmission chain and indicate via Relay for automatic indication and process control requirements.

### Typical Uses

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- Blocked chute detection
- Nucleonic switch replacement
- High level alarm / Low level alarm
- Truck / machine detection.

### Primary Areas of Application

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- Asphalt
- Brewing
- Cement
- Chemical
- Dairy
- Edible oil
- Fertilizer
- Food & Beverage
- Glass
- Mining & Metals
- Oil & Gas
- Packaging
- Paint
- Paper
- Pharmaceutical
- Plastics
- Power Generation
- Refining
- Semiconductor
- Sugar
- Textile
- Water & Wastewater.

### Function

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The Gladiator Microwave Switch can be used for blockage detection, barrier detection, machine detection, collision detection or protection and point level measurement, and detection of objects or material between two points.

### Features

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- State of the art circular polarisation
- Simple sensitivity adjustment and calibration
- Theoretical ranges up to 300m (984 ft)
- Simple '1-minute' setup application pre-sets
- Relay outputs: Integral (1 + failsafe)
- Remote test function
- Adjustable ON and OFF delays (0-20 sec)
- Remote 3G Hawklink connection option
- Bright visual status indication on sensors
- Independent housing alignment after mounting sensor.

# System Components / Dimensions

G1 Microwave Switch Series



## G1 Integral System

The G1 Integral System consists of 2 units. One Sender (G1S) and one Receiver (G1R)

G1S

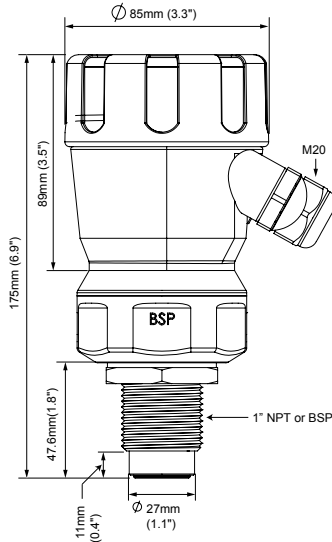


G1R



## Dimensions

G1S / G1R





# Dimensions

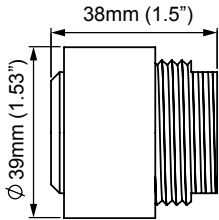
G1 Microwave Switch Series



## Mounting Accessories

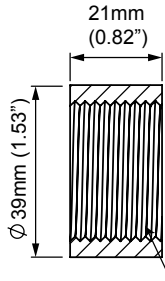
### MA1

(Consists of MA1-WC and MA1-UW)



### MA1-WC

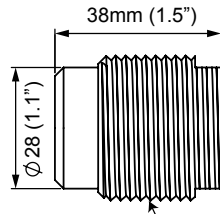
Weldment / Coupling



1" BSP  
internal thread

### MA1-UW

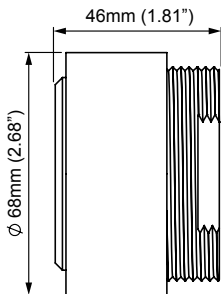
UHMW Window



1" BSP  
external thread

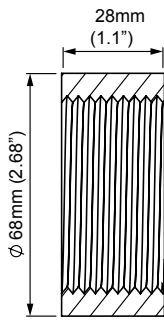
### MA2

(Consists of MA1-WC and MA1-UW)



### MA2-WC

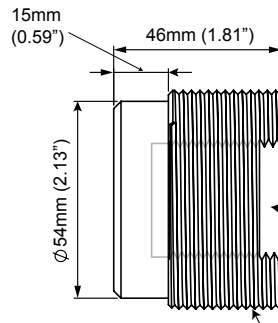
Weldment / Coupling



2" BSP  
internal thread

### MA2-UW

UHMW Window



1" BSP/NPT  
internal thread

2" BSP  
external thread

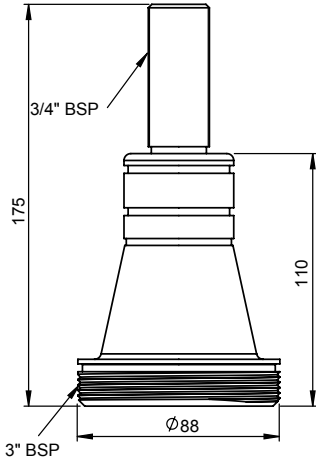
# Dimensions

G1 Microwave Switch Series

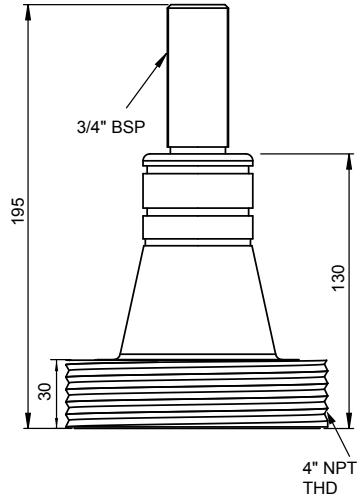


## Waveguides and Waveguide Accessories

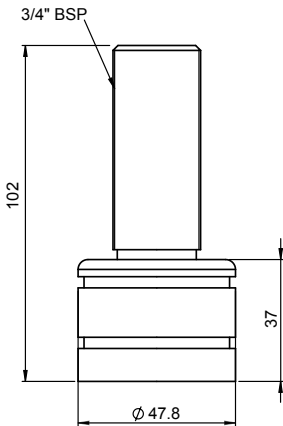
**MA-WG-04**



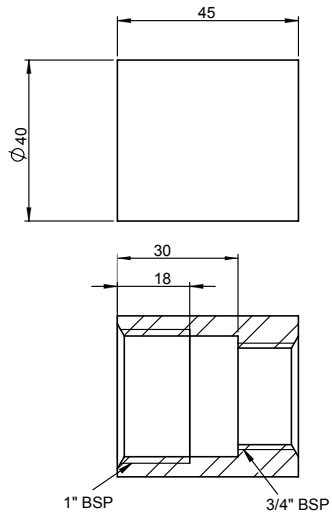
**MA-WG-04 with MA-WG14**



**MA-WG-03**



**MA-WG-01**



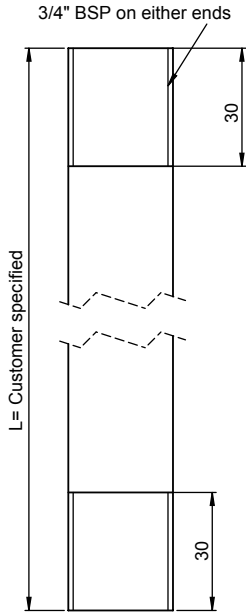
# Dimensions

## G1 Microwave Switch Series

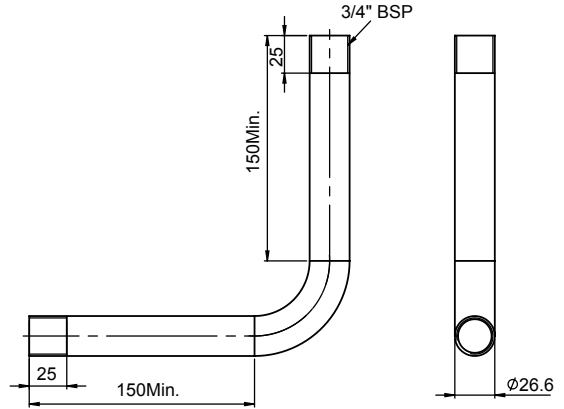


### Waveguides and Waveguide Accessories

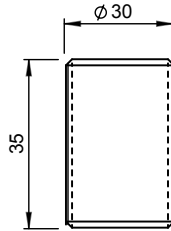
**MA-WG12-L=xxx**



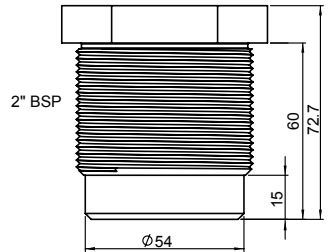
**MA-WG-02**



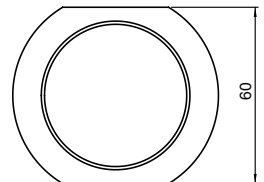
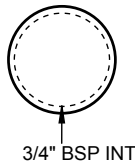
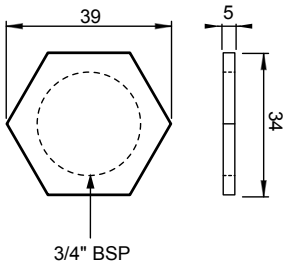
**MA-WG-13**



**MA-WG12**



**MA-WG11**

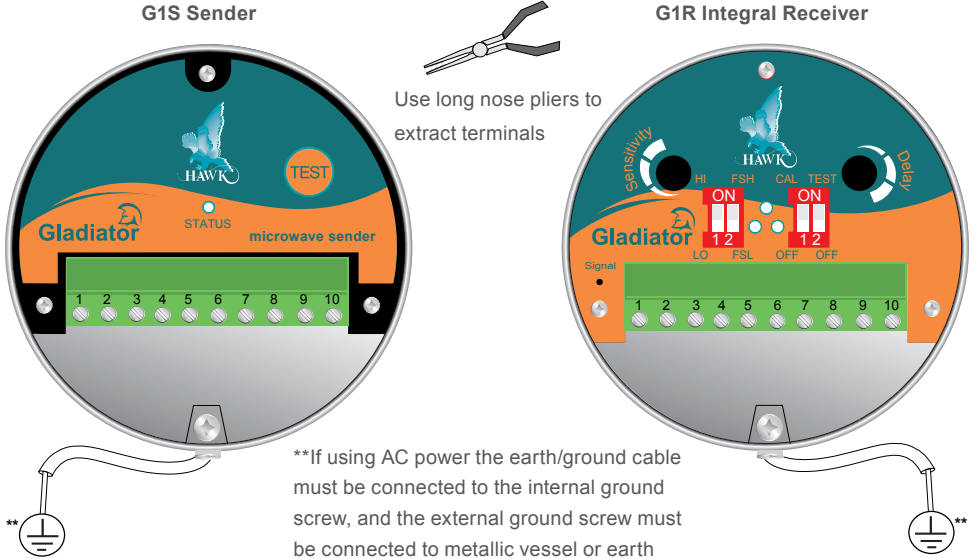


# Wiring & Indication

## G1 Microwave Switch Series



### System Connection



SENDER TERMINAL LAYOUT

						DC-IN		AC-IN	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
						+	-	N	L1
						12-30VDC		80-260VAC	

Terminals 1, 2, 3, 4, 5, 6 not used

RECEIVER TERMINAL LAYOUT

RELAY				COMMS		DC-IN		AC-IN	
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.
NC	COM	NO	Test	A	B	+	-	N	L1
				RS 485		12-30VDC		80-260VAC	
				Modbus D0 D1					

#### Sender

##### Status LED

- Green when powered
- Blinks while working correctly
- Solid while not transmitting

##### TEST button

Press and hold to test level relay action

#### Receiver

##### Status LED

- Green when powered
- High illumination = strong signal
- Low illumination = weak signal

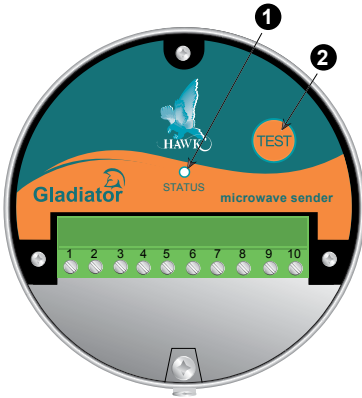
##### Signal Contact

Signal can be read with voltmeter across Signal contact point and earth screw (or other ground reference)  
2.4-2.5V is full signal. 0V is no signal

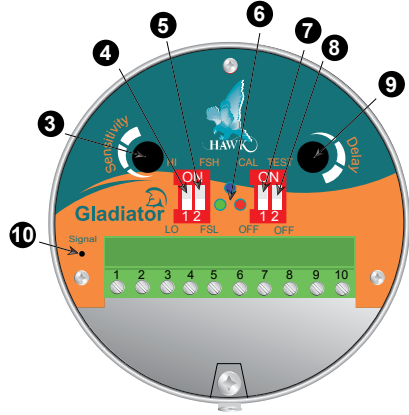


### Functionality Layout

**G1S Sender**



**G1R Receiver**



**(1) Sender status LED**

- Blinks while working correctly.
- Solid while not transmitting.

**(2) TEST button**

- Press and hold to test level relay action.

**(3) Sensitivity dial**

- Turn clockwise for switching in clean environments and object detection.
- Turn counter-clockwise for difficult applications, dusty/wet environments.

**(4) Hi / Lo switch**

- Hi mode for clean environments and object detection.
- Lo mode for difficult applications, dusty/wet environments.

**(5) FSH / FSL switch**

- FSH relay normally closed.
- FSL relay normally open.

**(6) Receiver status LEDs**

- Green - High illumination for good signal, Low illumination for weak signal.
- Red - Relay indication. Illuminated when closed.
- Blue - Cal mount indication - flashes during Cal mount, will stay illuminated if Cal mount fails.

**(7) Cal Mount switch**

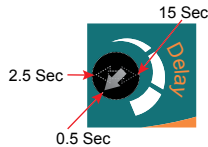
- Cal mount conducts the automatic setup routine for the system. Perform Cal mount for all new installations, and after adjusting either Sensitivity pot or Hi/Lo switch.
- Switch up to initiate Cal mount, wait several seconds, then switch back down. Unit will automatically complete Cal mount routine.

**(8) Test switch**

- Can be used for a failsafe / test relay.

**(9) Delay pot**

- Rotate clockwise to increase Relay on/off delay time.



**(10) Signal contact**


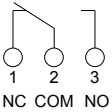

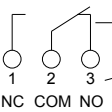

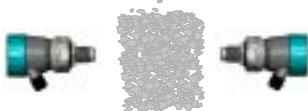
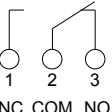

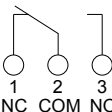

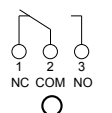

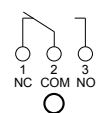

- Signal can be read with voltmeter across Signal contact point and earth screw (or other ground reference). 2.4-2.5V is full signal. 0V is no signal.

# Relay Functions

G1 Microwave Switch Series



## Relay Functions

	Relay Action	
	FailSafe Low FSL	FailSafe High FSH
<p><b>State 1</b> Clear path</p> 	 <p>1 2 3 NC COM NO</p> 	 <p>1 2 3 NC COM NO</p> 
<p><b>State 2</b> Blocked path</p> 	 <p>1 2 3 NC COM NO</p> 	 <p>1 2 3 NC COM NO</p> 
<p><b>Power Failure</b></p>	 <p>1 2 3 NC COM NO</p> 	 <p>1 2 3 NC COM NO</p> 

Relay Status

G1R terminal numbers

Red LED Status



### G1R Receiver Test Switch Functions

The test terminal has two potential modes of operation.

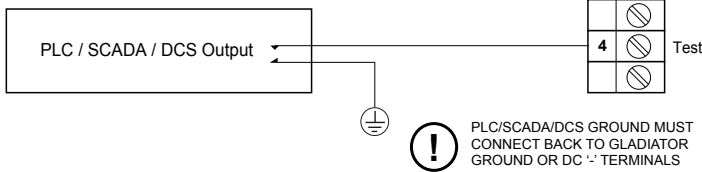
#### Test Input Mode

**Test Switch: ON**

Test terminal acts as an input for remote testing of the instrument's switching function. Used to check for malfunction of unit from a remote position, PLC, SCADA etc.

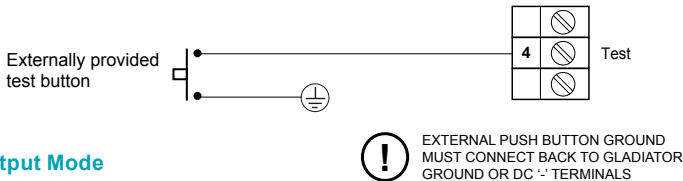
#### Test Input from PLC/SCADA/DCS Digital Output

#### Receiver Terminal Block



#### Operator Controlled Press To Test

#### Receiver Terminal Block

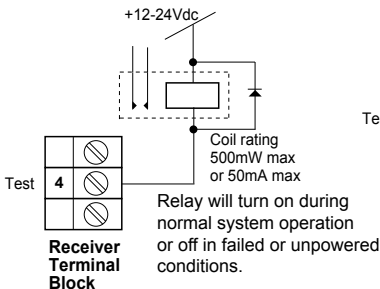


#### Failsafe Output Mode

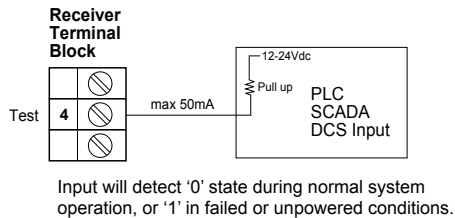
**Test Switch: OFF**

Test terminal will provide an output which is able to switch an external failsafe relay or PLC/SCADA/DCS input. During normal system operation this terminal will internally switch a solid state (transistor) output to ground (or DC '-'). If power fails or an internal system failure occurs, the terminal will act as an open circuit.

#### To switch an external relay



#### To a PLC input





### Weldment / Couplings and Windows

The weldment / couplings are designed to be welded into an appropriately sized hole in the vessel or application wall. A matching UHMW high wear window is then threaded into the weldment / coupling to act as a seal for the application.

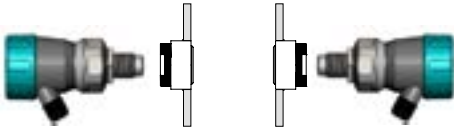
This typical installation isolates the Microwave hardware from coming into contact with any damaging materials and allows simple maintenance or replacement of units without having to unseal the process / application.

The Microwave transmission will pass directly through plastics to measure the material in the process.

#### MA2 - 2" Weldment / coupling with UHMW windows

Isolated from process with Weldment / Coupling and window

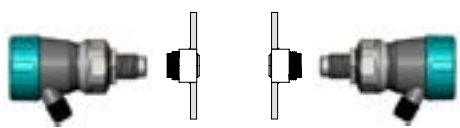
Mount maximum 100mm (4") back from Window



#### MA1 - 1" Weldment / coupling with UHMW window

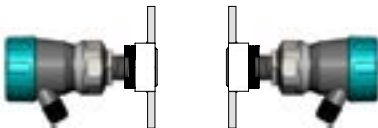
Isolated from process with Weldment / Coupling and window

Mount maximum 100mm (4") back from Window



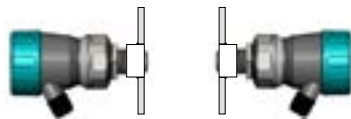
Isolated from process with Weldment / Coupling and window

Mounted to MA2-UW threaded window



Sensing element within process

Mounted to MA1-WC threaded weldment / coupling





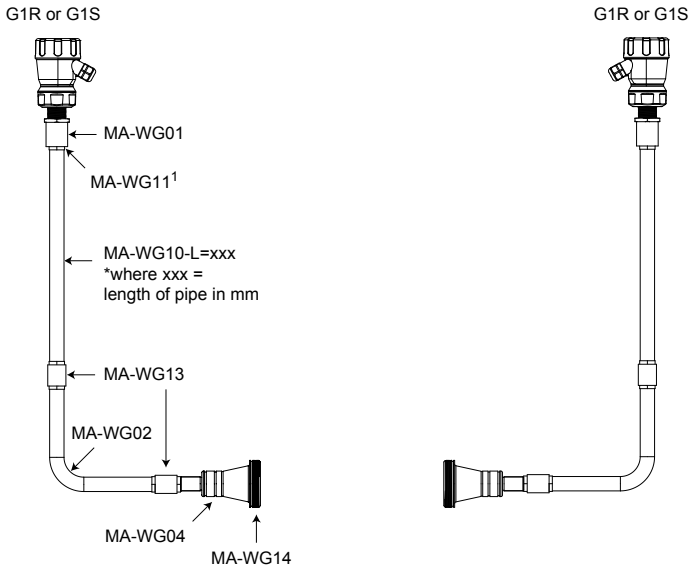


### Waveguides

System with Waveguide extensions for remote mounting / signal transmission.

Waveguides can be used for difficult to access areas or to isolate the electronics from high temperature or non-compatible processes.

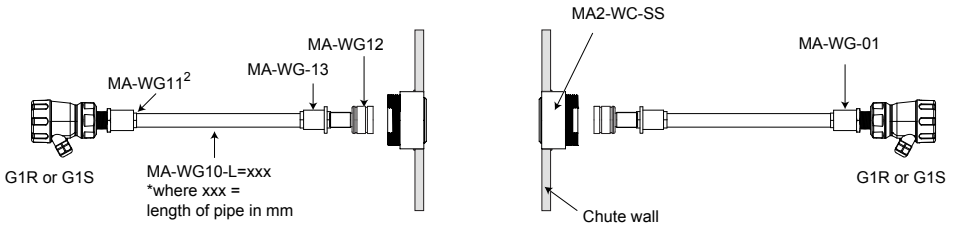
For further information on Waveguides see G1 Waveguide parts and assembly guide document available at <http://www.hawkmeasure.com>



<sup>1</sup>Displayed drawing includes qty 5 of MA-WG11 locking nut per side

### Mounting Example

System with Waveguide extensions with MA2-WC-SS window and weldment/coupling application seal.



<sup>2</sup>Displayed drawing includes qty 3 of MA-WG11 locking nut per side



### General Requirements

1. When looking for a mounting location it is important to locate and mount the interior of the window/sensor face for each unit flush with the vessel wall and where minimal build-up will occur.

For chute type applications the maximum recommended distance between the Sensor and the chute / window is 100mm (4"). Use Waveguides if electronics cannot be mounted to this requirement.

A cavity or tubed mount in the vessel where the sensor is mounted may fill with process material and will result in a 'plug' forming in front of the beam path resulting in unwanted false trips or unit performance issues.

2. Microwave energy cannot penetrate through steel linings or other conductive linings. You must cut a viewing hole and use an appropriate windowed weldment.

3. For high vibration applications, it is necessary to isolate the electronics to keep them from long term damage. This is most often accomplished using 2" UHMW or Teflon windowed weldments in the vessel walls, and mounting the Microwave Sender and Receiver to a separate stable structure (I-beam, handrail) to isolate them from vibration.

4. For high temperature applications which exceed specified maximum temperature it is necessary to ensure that the sensors always remain below 65°C/150°F. Use waveguide assemblies to the high temperature area with the electronics in an appropriately rated area.

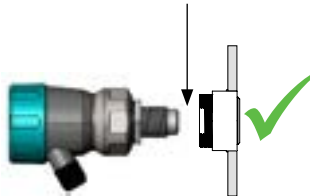
When mounting to monitor the level of a flowing product such as coal, ore or wood chips, position the microwave path out of the direct product flow stream. If at all possible, go behind the flow stream or well in front of it. This will minimise any possibility of unwanted trips due to abnormal product flow blocking the beam.

When using the system as a proximity switch such as truck detection the mounting arrangement is application dependent and must ensure proper operation even under worst case conditions.



**Do not mount with cavity**

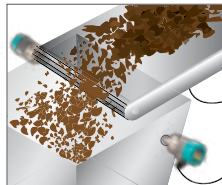
**Maximum distance between Sensor Face and chute: 100mm (4")**



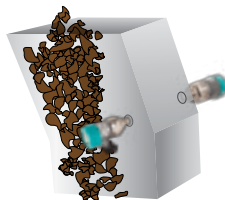
**Mount behind flush Weldment / Coupling with Window**



**Mount behind flush Weldment / Coupling with Window**



**Mount away from main product flow**



# Setup Procedure

## G1 Microwave Switch Series



### Setup Procedure

#### 1. Mount the units according to Mounting Requirements

1.1 If units are AC powered ensure proper grounding is connected to ground screw.

#### 2. Powering the unit

The green status LED on the G1S Sender will blink while working correctly or be solid if not working correctly or not transmitting.

The green LED on the G1R Receiver will stay on permanently to indicate that power is on. The intensity of illumination of the light indicates signal strength (high intensity indicates good received signal).

#### 3. Select the required relay action

The Relay can switch 'ON' (FSL) or 'OFF' (FSH) as the microwave beam is blocked. Set the relay action selection switch position depending on your requirements. FSH is recommended (ordinarily on/energized, switches off/ DEN during blocked conditions).

#### 4. Select the Sensitivity

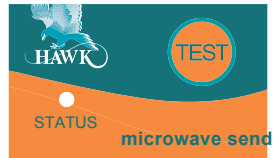
There are two adjustments controlling the sensitivity of the switch point:

4.1 The 'HI/LO' sensitivity switch is used as the primary sensitivity setting. Select LO sensitivity for Blocked Chute detection and if build-up is expected over sensors. Select HI sensitivity for clean environments, object detection and lighter/less absorptive material or targets. LO recommended for most applications.

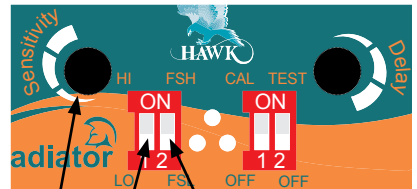
#### 4.2 The Sensitivity Dial

Turning the pot fully counter-clockwise factory recommended for blocked chute applications. If operating in HI mode set the pot to 12 o'clock. In this mode you can turning the pot clockwise to reduce the amount of beam blockage required for switching and vice versa.

G1S Sender



G1R Receiver



Sensitivity Dial  
Sensitivity Switch  
Relay Action Switch

# Setup Procedure

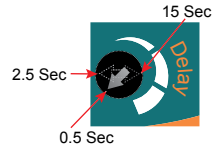
## G1 Microwave Switch Series



### Setup Procedure

#### 5. Select the relay time delay

Full anti clockwise is minimum (0.1 seconds). Full clockwise is maximum (20 seconds). Adjust as required allowing time to avoid possible nuisance trips. The selected delay will be used for both an ON delay and an OFF delay.



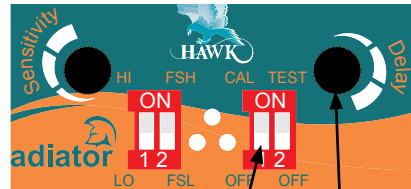
#### 6. Perform a CAL mount

Do not proceed with this step unless there is clear path between the Sender and Receiver.

Switch CAL switch on the Receiver unit to ON position. The Blue LED will blink to indicate that mounting calibration is now in progress. Wait 5 seconds, then switch the mounting calibration switch to 'OFF' position.

The blue LED will switch off after successful calibration. If it stays on this indicates there was a calibration error. If this is the case please check that the path between sender and receiver is clear and alignment is correct. You may need to lower the Sensitivity setting. Try the calibration again. If mounting calibration was successful the blue LED should be off and the Green LED should be ON.

#### G1R Receiver



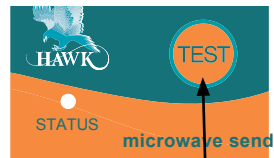
Cal Mount Switch      Delay Pot

#### 7. Relay test

If required block the Sender with a sample of the application material (note the units are capable of penetrating significant amounts build up). The green LED will dim when the Microwave beam begins to be blocked.

You can also press the 'TEST' button on the Sender to simulate the switch condition and trigger the relay action.

#### G1S Sender



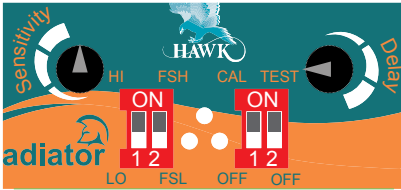
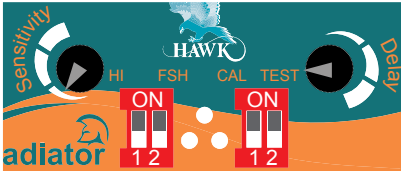
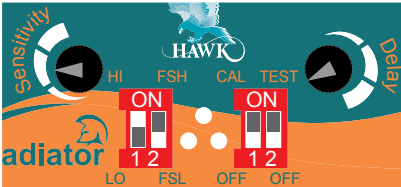
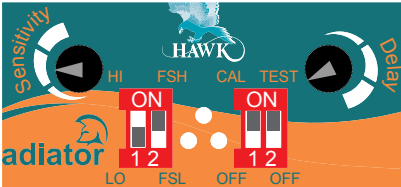
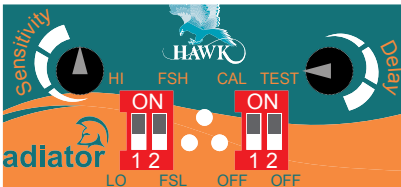
Relay Test Button

# Typical Setup

G1 Microwave Switch Series



## Typical Setups

Application	Setup
Chute Switch	 <p>Sensitivity Pot: 12 o'clock Sensitivity Switch: Lo Delay Pot: 9 o'clock</p>
Chute Switch (dirty conditions)	 <p>Sensitivity Pot: Fully counter-clockwise Sensitivity Switch: Lo Delay Pot: 9 o'clock</p>
Vehicle / Machine detection	 <p>Sensitivity Pot: 9 o'clock Sensitivity Switch: Hi Delay Pot: 8 o'clock</p>
Presence / Absence switch (clean environment)	 <p>Sensitivity Pot: 9 o'clock Sensitivity Switch: Hi Delay Pot: 8 o'clock</p>
Presence / Absence switch (dirty environment)	 <p>Sensitivity Pot: 12 o'clock Sensitivity Switch: Lo Delay Pot: 9 o'clock</p>



### Modbus Registers

Comms A / B on the G1R unit (see Wiring page) can be used for Modbus networking

A = Modbus D0 (+) B = Modbus D1 (-)

Title	Address	Operation	Notes
Relay Status	126	Bit 9 indicates relay status	
Switch Value	122	Data Range 0-1000 0 = No blockage 1000 = Full blockage	Unit should read 0 after performing a Cal Mount. Increasing values can indicate application difficulties and provide warning for build up or maintenance checks.
Device ID	4	Data Range 1-255	Can be written or read. Value = ID
Restart Unit	100	Write Data 32768 to re-start unit	

### Troubleshooting

Problem	Check
Unit Relay incorrectly tripping	Ensure no material build up is between the sensors. Ensure mounting is correct to mounting guidelines. Adjust unit settings to 'Lo' Sensitivity modes.
Unit Calibration fails (Blue LED stays illuminated)	Ensure no material build up is between the sensors. Ensure mounting is correct to mounting guidelines. Rotate Sensitivity pot anti clockwise. Adjust unit settings to 'Lo' Sensitivity modes. Bench test system with different Sender and Receiver. Replace faulted unit.
Relay flickers on/off (relay chatter)	Increase 'Delay' time. Reduce Sensitivity / Switch to Lo Sensitivity mode. Check for material build up in between the sensors. Ensure mounting is correct to mounting guidelines.
Switch / Relay testing	The units are designed to penetrate through generous amounts of material build up, small or thin objects may not be appropriate for Switch testing. Use the 'Test' button on the Sender unit to confirm unit Relay function is correct. The green LED on the Receiver (G1R) will dim when the signal is partially blocked. In some applications the unit beam spread may bounce around the target. Increase Sensitivity or use Waveguides to control the transmitted beam closer to the target or chute.
Relay does not switch when pressing 'Test' button during Switch testing	Bench test system with different Sender and Receiver. Replace faulted unit if required. Place a DC voltage Multimeter across Signal (+) contact and the (-) to an earth source on the G1R Receiver. This will read a DC voltage up to 2.5V while full signal is present on a healthy unit. When 'Test' button is pushed a low/no value (<0.010VDC) will be indicated. If while 'Test' button is pushed a signal is still present replace G1R Receiver.
Sender (G1S) green LED is permanently solid	This indicates the Sender is not transmitting. Ensure wiring is correct. Confirm incoming voltage is to correct specification. Replace with new Sender unit.
No LEDs illuminated on either unit	Ensure wiring is correct. Confirm power is present at the correct terminals and incoming voltage is to correct specification. Bench test system and replace any failed hardware.

# Part Numbers

## G1 Microwave Switch Series



### Electronics

#### Model

- G1S** Gladiator 1" Microwave Integral Sender
- G1R** Gladiator 1" Microwave Integral Receiver, 1 Relay with Failsafe

#### Electronics Housing (Sensor element is 316L with Teflon face)

- S** Powder Coated Aluminum
- C** 316L Stainless Steel

#### Power Supply

- B** 12-30VDC
- U** 12-30VDC and 80-260VAC

#### Mounting Thread

- TB** 1" BSP
- TN** 1" NPT

#### Approvals

- X** Not Required
- A22** ATEX Grp II Cat 3 GD T85°C IP67 Tamb -40°C to 70°C

**G1S C B TB X**

#### Mounting Accessories

##### MA

- 1** 1" UHMW Window & mild steel weldment/coupling each
- 1-SS** 1" UHMW Window & 316L stainless steel weldment/coupling each
- 1-UW** 1" UHMW Window each
- 1-WC** 1" mild steel weldment/coupling each
- 1-WC-SS** 1" 316L stainless steel weldment/coupling each
- 2** 2" UHMW Window & mild steel weldment/coupling each
- 2-SS** 2" UHMW Window & 316L stainless steel weldment/coupling each
- 2-UW** 2" UHMW Window each
- 2-WC** 2" mild steel weldment/coupling each
- 2-WC-SS** 2" 316L stainless steel weldment/coupling each

**MA 2**

*Additional mounting accessory variants and materials including high temperature ceramics are available. See Gladiator Gen 3 Microwave datasheet available at [www.hawkmeasure.com](http://www.hawkmeasure.com)*

#### Waveguides

##### MA-WG

- 01** 316L Threaded connector for Sender / Receiver
- 02** 316L 90deg bend pipe (150mm + 150mm). Includes qty 2 of MA-WG11
- 03** 316L 1-1/2" Wave guide horn. Includes Qty 1 MA-WG13
- 04** 316L 3" Wave guide horn. Includes Qty 1 MA-WG13
- 10-L=1** 316L Straight pipe extension 1L= length in mm. Includes qty 2 of MA-WG11
- 11** 316L Locking nut
- 12** 2" BSP Teflon plug with socket to match MA-WG03 horn
- 13** 316L Pipe to pipe connector coupling
- 14** 4" Teflon window to match MA-WG04 Horn. Fits into MA18 weldment

**MA-WG 01**

# Specifications

## G1 Microwave Switch Series



### Operating Voltage

- 12-30VDC (residual ripple no greater than 100mV)
- 80-260VAC.

### Power Consumption

- <0.8W @ 24VDC
- <5VA @ 240VAC
- <3VA @ 115VAC.

### Communications

- GosHawk, Modbus
- Multidrop mode can address 1-250 units over 4 wires.

### Relay Output

- Form 'C' (SPDT) contacts, rated 5A at 240Vac resistive
- Remote fail-safe test facility for one relay.

### Operating Temperature

- Integral Units -30°C (-20°F) to 65°C (150°F)\*.
- \*For higher temperature applications, remote waveguide mounting with appropriate windows is necessary.

### Power Density

- Rated from emitter to receiver at approximately 20μW/cm<sup>2</sup>
- Complies with FCC Title Rules Part 15 (Beam Blockage)
- Caution sign posting not required.

### Transmitted Signal

- Circular polarisation polarity
- Frequency: 10.525GHz
- Power: +14dBm / 25mW
- Sensitivity -88dBm
- Beam width 50°

*Specifications model dependant*

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### Fail-Safe

- Selectable - presence or absence of material
- High level fail-safe: relay is activated when material is present.
- Low level fail-safe: relay is activated when no material is present.

### Range

- Theoretical maximum range: 300m (984 ft)
  - Recommended range (chutes) 15m
  - Recommended range (object detection) 50m
  - Minimum range under ideal conditions: 10cm (4 inches).
- Note: Minimum ranges are dependent on application conductivity.*

### Maximum Operating Pressure

- 2 BAR.

### Enclosure Sealing

- Integral Sensors IP67.

### Wetted Materials

- Sensing element housing: 316L stainless steel
- Sensing element face: Teflon.

### Cable Entries

- Integral Units: 2 x M20 Glands / 3/4" NPTF threaded adapters.

### Mounting

- 1" NTP
- 1" BSP.

### Remote Test Input

- Press to test (used to check for malfunction of unit from remote position, PLC, SCADA etc).

### Weight

- G1R 1kg
- G1S 1kg.

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