XM000002
Rev. 007

WASP-200 LRF

USER MANUAL - UART (CU1 AND MU1) AND CAN / RS-232 (MC1) VERSIONS

ATTOLLO ENGINEERING

Contents

Laser Safety

WARNING

This device does not require regular maintenance. If the device becomes damaged or is inoperable, repair or service must be handled by factory authorized technicians only. Attempting to modify, repair or service the unit on your own will not only result in voiding the warranty, but is prohibited and could result in direct exposure to laser radiation and permanent eye damage.

For repair or service, contact Attollo Engineering for more information. Attollo Engineering is not responsible for injuries caused through the improper use or operation of this product.

CAUTION

Caution – use of controls or adjustments or performance of procedures other than those specified herein may result in hazardous radiation exposure.

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Camarillo, CA 93012

This Laser Product is designated Class 1 during all procedures of operation. As designed, the laser is safe to look at with the unaided eye, however, it is advisable to avoid looking directly into the beam when operating the device and to turn off the unit when not in use.

Introduction

The WASP-200 LRF is an ultra-compact laser rangefinder (LRF) device that is capable of quickly and accurately identifying the distance to a target ~130 m away assuming 18% or better target reflectance and under full sun illumination conditions; and even further away with higher reflectance targets and/or lower solar illumination levels. The WASP-200 LRF supports range update rates of up to 56 ranges-per-second with improved accuracy at lower repetition rates with a variety of filtering and averaging features. Attollo has three configurations of the WASP-200 LRF:

- CU1 – UART communication interface
- MU1 – Ruggedized, IP67, UART communication interface
- MC1 – Ruggedized, IP67, CAN and RS-232 communication interface using the Cloud Cap Technology Piccolo autopilot protocol

NOTE: This Laser Product is designated as Class 1 during all aspects of operation.

The WASP-200 LRF has been designed with ease of use and flexibility in mind and therefore supports a +5V-compliant UART communication interface (CU1 and MU1 models) and requires just power and ground to operate out of the box. The UART interface can be used to set and save various user parameters and operating modes tailored to your specific application.

The MC1 is a ruggedized version of the WASP-200 laser rangefinder that is IP67 compliant and is directly compatible with the Cloud Cap Technology Piccolo autopilot systems using their CAN and RS-232 interfaces. In addition to the Piccolo CAN interface, the user can access all of the commands and settings of the WASP-200 over the RS-232 interface to set the various user parameters and operating modes for use while operating with the Piccolo flight controller.

Principle of Operation

The WASP-200 LRF uses a highly sensitive avalanche photodetector (APD) and short-pulse laser diode. The laser is pulsed to produce an optical pulse of laser light with a peak power of about 40 Watts. This pulse is collimated with a lens and transmitted to the target up to 250 meters away (the maximum range capability of the WASP-200 LRF). A small portion of the light will bounce off the targeted object and end up traveling back to the WASP-200 LRF where it will be collected by the receiver lens and focused onto a small avalanche photodetector. This light will cause an avalanche of electrons to flow in the detector thus producing a current pulse which is subsequently amplified and converted into a voltage pulse.

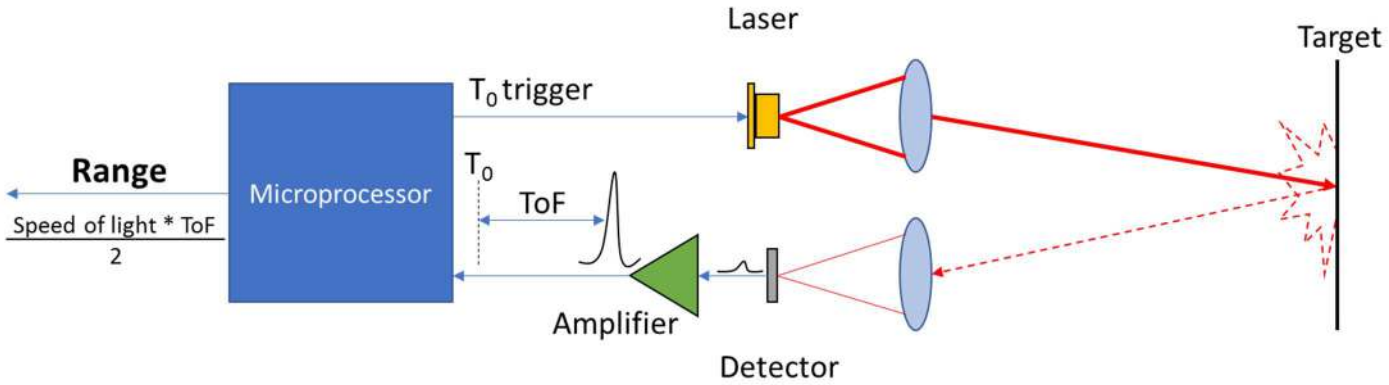

Figure 1 - Conceptual Schematic of the WASP-200 LRF time-of-flight principle of operation

The WASP-200 LRF makes a careful timing measurement between the firing of the laser and the receipt of the detector's signal pulse. This elapsed time, called the time-of-flight (ToF), is used to determine the distance to the object based on the speed of light and taking in to account the round-trip path of the light pulse.

The WASP-200 LRF has an on-board microprocessor which performs many functions throughout the idle and operating states of the rangefinder. Examples include maintaining a high sensitivity state of the APD under changing environmental and illumination conditions, performing burst mode averaging of returns when requested, applying calibration parameters to the detected pulse to compensate for variability in target properties, compensating for changes in the ambient temperature, etc.

The default baud rate for the serial communications is 115,200 bits per second. 115,200 bps is sufficient for ranging up to approximately 1,500 ranges-per-second. Software allows for the baud rate needs to be increased to 921,600 bps. At either baud rate, the range reporting format can be changed to binary to enable data to be reported up to the maximum range rate of 10,000 ranges per second over the serial port for Class 3 operation only. Class 1 is limited to a 56 Hz maximum range rate.

Anytime the system cannot respond immediately to a range based on a requested range rate, the WASP-200 LRF reports a code which will be denoted by a negative sign and a numeric code.

Performance

Using the built-in, real-time filtering functions (AVG, MAVG, MEDF) will re duce the maximum achievable repetition rate. In repetitive ranging mode, the system will take the time necessary to apply the active filters to the current measurement and then wait for the next internal trigger. If the time required to apply the filters exceeds a period time, the system will wait until the next period before beginning another range operation. The DIG_OUT will generate a ~5 us pulse every time the system is carrying out a ranging operation and is time synchronized to the start of the laser pulse.

Power

The WASP-200 LRF is designed to operate with a wide range of input voltages. The steady state current is generally below 75 mA at a 5V operating voltage and may require temporary inrush currents of up to 100 mA upon power-on.

Table 1 - Performance specifications of the WASP-200 LRF.

WASP-200 LRF	
Specification / Feature	**CU1/MU1/MC1**
FDA Laser Classification	This is a CLASS 1 Laser Product
Range Performance (Scattering Sunlit Target)	**0.2m to 125m - 18% reflectivity** **0.2m to 200m - 80% reflectivity**
Maximum Range	315 meters
Accuracy	< 10 cm
Resolution	1 cm
Update Rate	Single shot to 56 Hz
Wavelength	905 nm
Beam Divergence	8 mrad x 1 mrad
Optical Aperture	18 mm
Input Voltage	5V to 16V (CU1/MU1) 7V to 13.8V (MC1)
Current @ 1 Khz	< 75mA @ 5V Operating Voltage (CU1/MU1)
Inrush Current	< 100mA @ 5V Operating Voltage (CU1/MU1)
Connector	8 pin Hirose Connector, Pigtail, or IP67 ODU
Communication Interface	UART (CU1/MU1), CAN/RS-232 (MC1)
Dimensions (L x W x H)	44 x 20 x 42 mm^3 (CU1/MU1)
Weight	26 grams (CU1)
Operating Temperature	-40 to + 60 C (-40 to 140 °F)

Laser Safety

The WASP uses a 905 nm, 75 W peak power laser with a beam divergence of 8 mrad x 1 mrad out of an 18 mm aperture.

NOTE: This Laser Product is designated as Class 1 during all aspects of operation. The U.S. FDA Laser Classification Label is shown below in Figure 2. The placement of the labels is shown in Figure 3 and Figure 4.

Figure 2 - U.S. FDA Class 1 Laser Label

Physical

There are two configurations of the WASP-200 LRF: Commercial (CU) and Ruggedized (MU and MC). The commercial version features an injection molded plastic housing and a UART interface over a Hirose DF13 8-pin connector. The ruggedized version utilizes a machined plastic housing base unit with IP67-designed sealing and an accessory module that provides a CAN & RS-232 or a UART interface to the host system.

Table 2 - WASP-200 physical device configurations.

WASP-200 LRF		
Specification / Feature	**Commercial (CU1)**	**Ruggedized (MU1/MC1)**
Dimension (L x W x H)	44 x 20 x 42 mm^3 (1.7 x 0.8 x 1.5 in^3)	44 x 34.8 x 42 mm^3 (1.7 x 0.8 x 1.5 in^3)
Connector	Hirose DF13	ODU IP67
Water Protection	Splash Resistant	IP67 Rating
Weight	26 grams (0.92 oz.)	35 grams **(TBD)** (1.24 oz.)
Operating Temperature	-40 to + 60 C (-40 to 140 °F)	-40 to + 60 C **(TBD)** (-40 to 140 °F)

Two options for mounting the WASP in a system have been provided.

Option 1 – Rear mounting: There are four 0.150” diameter holes on the rear cover dog ears to flush mount the unit to a mounting surface. The holes are well-suited for a close clearance with a #6-32 socket head cap screw or they can be drilled out for slightly larger screws.

Option 2 – Front mounting: The WASP-200 LRF can be mounted to a host-system by way of the 0.067” holes found on the front of the device and be flush-mounted to a 3/16” plate or panel. The mounting hole can be tapped for a #2-56 thread.

Dimensions

The exterior dimensions and mounting details of the WASP-200 LRF are shown in Figure 3 for the commercial system and Figure 4 for the ruggedized system. All dimensions are in millimeters. Contact Attollo Engineering for a 3D solid model.

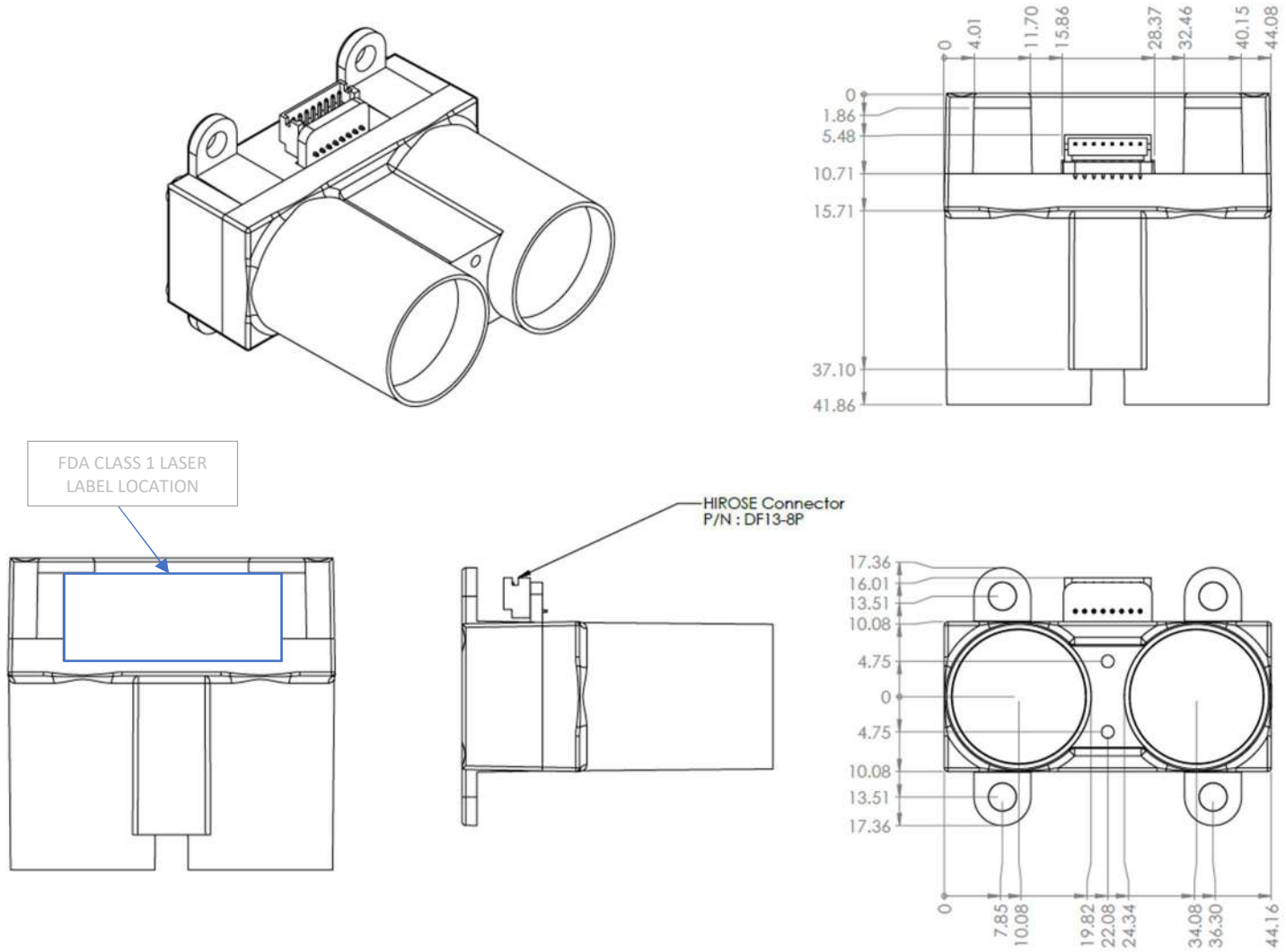

Figure 3 - Exterior and Mounting of the WASP-200 LRF (CU1)

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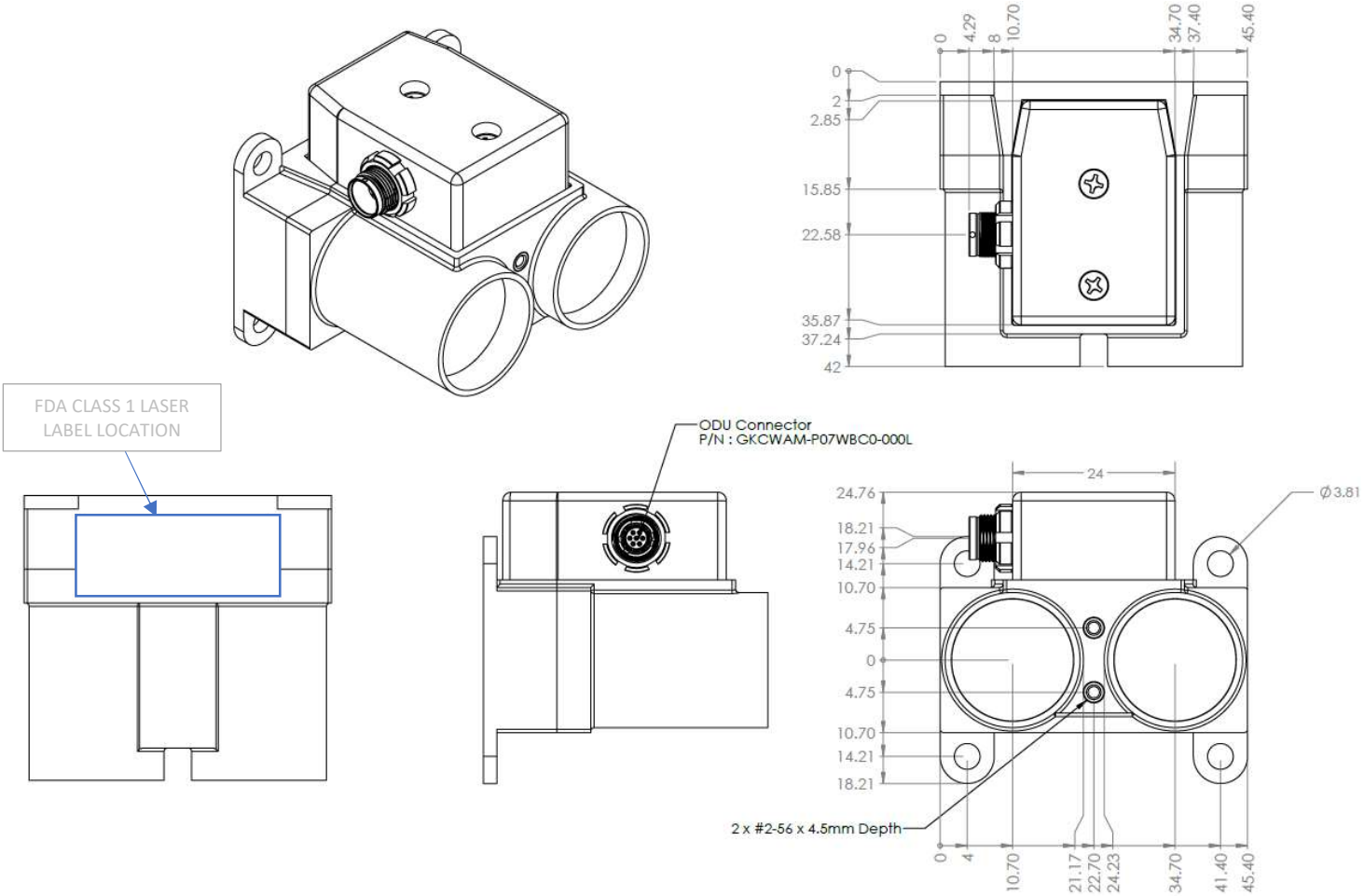

Figure 4 - Exterior and mounting dimensions of the Ruggedized WASP-200 LRF (MU1 and MC1)

Filtered False Alarm Rejection

False alarms are an inherent artifact of high performance rangefinders. Spurious electrical noise spikes or ambient background noise spikes may exceed the extremely sensitive thresholds set for maximum range capability and cause an incorrect range to be reported. Attollo has designed the WASP to have an approximately 1.0% false alarm rate (FAR) which is a generally accepted FAR for typical usage. The FAR can be improved (i.e. to 0.1%) by increasing the threshold, but this will come at the cost of range performance. Generally, the user has some sort of filtering mechanism to invalidate clear false alarms or reduce their impact on the control system.

However, in the case of when a series of ranges is considered to create a single output value, for instance in the case of the average filter (AVG) or moving average filter (MVG), false alarms need to be dealt with intelligently so that the output value is accurate and a 1% FAR does not end up manifesting itself as a higher rate due to the aggregation of ranges into a single output value.

To address this, the WASP applies a false alarm filtering mechanism in both the averaging mode and moving average mode to detect and throw out high probability false alarms from the reported averaged value. The filter does this by applying a series of thresholds to the measured values compared to the median or average value of the population to determine whether a given value is a false alarm or a valid measurement.

For the averaging mode, if the user selects an averaging of 8 pulses (`AVG8`), the WASP will take 8 ranges in quick succession, computes the median, and then compare each range to the median. If a given range exceeds the median by the parameter stored by AVF (i.e. 2.00 meters by default), longer or shorter, then that range is thrown out and not included in the reported average.

For the moving average mode, if the user selects a moving averaging of 8 pulses (`MVG8`), the WASP will take a range and adds it to the 8 range queue, computes the average of the queue, and then compares each range to the average of the queue. If a given range exceeds the average by the parameter stored by the percentage expressed by MVF (i.e. 0.20 by default), longer or shorter, then that range is thrown out and not included in the moving average.

For both modes (`AVG` or `MVG`) the last parameter, `RGF`, describes the range above which these algorithms are applied. In other words, if a range is below the default value of 30.0 meters then these algorithms are not applied to incoming data in `AVG` or `MVG` mode.

We have found both of these techniques and the default values associated with them to support high accuracy ranging with low false alarm rates in typical environments when operating with the average and moving average filters. In fact, with these filters the effective false alarm rate in the average or moving average mode is signficantly improved over the 1% because of this additional level of filtering.

The filtering is adjusted by three parameters, AVF, MVF, and RGF. By default these values are 2.00, 0.20, and 30.0, respectively. Generally the user will not need to change these parameters but there may be environmental factors (i.e. high frequency variation in actual range) that may require this feature to be deactivated.

Pinout and Electrical Interface

CU1

The signals used in operation of the commercial WASP-200 LRF (CU1) are shown in the following table. The user is free to make their own cable set but cables received from Attollo will be colored per the table below.

Table 3 - WASP-200 LRF Signal Pinouts for the CU1 model.

Pin # (CU1)	Signal	Voltage Range	Comment	Color
1	RST	0 - 3.3V	3.3V or float for normal operation 0V for greater than 10 us to reset system	Brown
2	GND	0V		Black
3	POWER IN	3.5 - 16V		Red
4	POWER ENABLE		3.3V or connect to POWER IN to enable system 0V or float to disable system	Green
5	UART RX	0 - 3.3V	5V tolerant	Blue
6	UART TX	0 - 3.3V		Orange
7	DIGITAL OUT	0 - 3.3V		Yellow
8	DIGITAL IN	0 - 3.3V	5V tolerant	Purple

Eight plated through holes, on a 1.25 mm pitch are provided on the PCB tab of the WASP-200 LRF for direct soldering of interface wires or an 8-pin, 1.25mm pitch connector. Most WASP-200 LRFs ship with a Hirose DF13-8P-1.25DS(20) 8-pin connector though others will work. Recommended connectors and mating components are listed in Table 4.

Table 4 - Recommended connectors and wires for the WASP-LRF CU1 model.

Part	Description	Mfg	Mfg P/N
Board Connector	**8 Position Header Connector 0.049" (1.25mm) Through Hole, Right Angle Tin**	Hirose	DF13-8P-1.25DS(20)
Wire Housing / Mating Connector	**8 Position Rectangular Housing Connector Receptacle Beige 0.049" (1.25mm)**	Hirose	DF13-8S-1.25C
Wire	**26 – 30 AWG Wire**	-	-

MU1

The MU1-001 uses a 7-pin circular IP67-rated connector from ODU for the power, communication, and I/O connection to the LRF.

Table 5 - MC1-0017-pin circular connector and mating part.

MU1-001 Connector	ODU GKCWBM-P07WBC0-000L
Mating Connector	ODU A1CWBM-P07XBC0-0000

Note that the MU1-001 uses use the "B" keyway of this connector family. The MU1-001 connector, from the perspective of looking at the connector from the outside of the LRF, is numbered according to Figure 7.

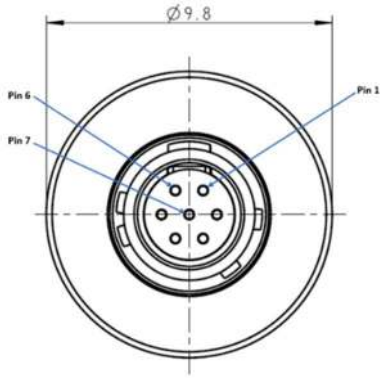

Figure 5 - MU1 - 7 Pin Circular Connector (ODU GKCWBM-P07WBC0-000L) pin numbering. Minor keyway information in drawing may not be accurate but pin numbering with respect to the large key is accurate.

The pinout of the connector is defined in Table 8. Mating connectors and cable sets can be purchased from Attollo and are color coded as indicated in Table 8.

Table 6 - WASP-200 LRF Signal Pinouts for the MU1 model.

Pin # (MU1)	Signal	Voltage Range	Comment	Color
1	RST	0 - 3.3V	3.3V or float for normal operation 0V for greater than 10 us to reset system	Brown
Shell/Drain	GND	0V		Black
7	POWER IN	3.5 - 16V		Red
5	POWER ENABLE		3.3V or connect to POWER IN to enable system 0V or float to disable system	Green
2	UART RX	0 - 3.3V	5V tolerant	Blue
4	UART TX	0 - 3.3V		Orange
6	DIGITAL OUT	0 - 3.3V		Yellow
3	DIGITAL IN	0 - 3.3V	5V tolerant	Purple

*Note that there are two black wires on the pigtail end of the cable. However, one is heatshrink wrapped and is not fully insulated at the base where it meets the thick plastic insulation. This is the cable braid / drain of the cable. The black GND signal is stripped only at the tip like all of the other wires.

Minimum Recommended Configuration (CU1 and MU1)

To operate the WASP-200 LRF with a minimal electrical configuration the cable can be configured like that shown in Figure 6.

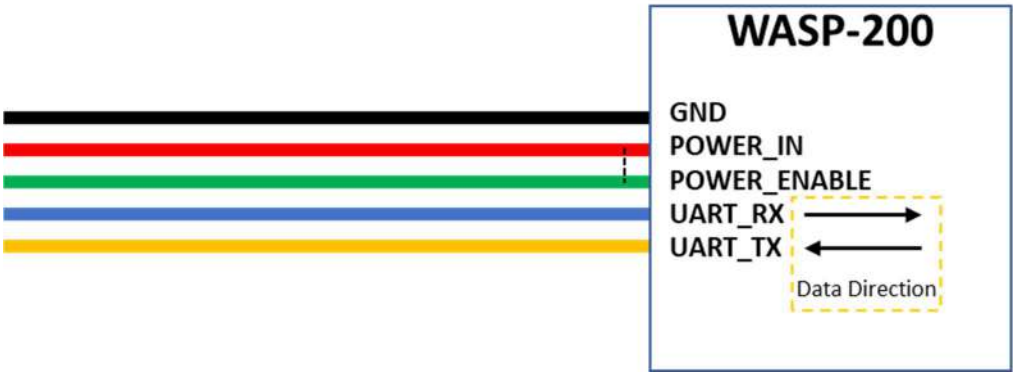

Figure 6 - The minimum required connections to operate the WASP-LRF

POWER_ENABLE can be tied to POWER_IN to simplify the number of connections. POWER_ENABLE can tolerate the full voltage range (4.7V – 16 V) of POWER_IN.

MC1

The MC1-001 uses a 7-pin circular IP67-rated connector from ODU for the power, communication, and I/O connection to the LRF.

Table 7 - MC1-0017-pin circular connector and mating part.

MC1-001 Connector	ODU GKCWAM-P07WBC0-000L
Mating Connector	ODU A1CWAM-P07XBC0-0000

Note that the MC1-001 uses use the "A" keyway of this connector family. The MC1-001 connector, from the perspective of looking at the connector from the outside of the LRF, is numbered according to Figure 7.

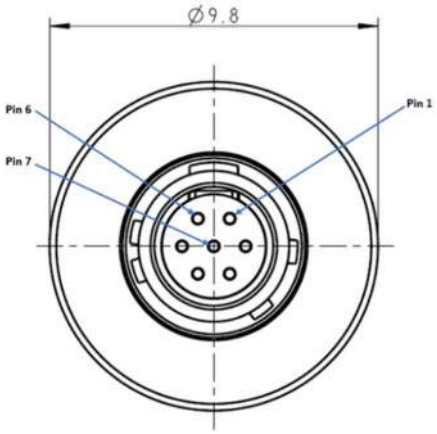

Figure 7 - MC1 - 7 Pin Circular Connector (ODU GKCWAM-P07WBC0-000L) pin numbering

The pinout of the connector is defined in Table 8. Mating connectors and cable sets can be purchased from Attollo and are color coded as indicated in Table 8.

Table 8 - WASP-200 LRF Signal Pinouts for the MC1 model.

Pin #	Signal	Voltage Range	Comment	Color
1	RS-232 RX	0 - 3.3 V		Brown (or Gray)
6	RS-232 TX	0 - 3.3 V		Black
2	POWER IN	7 to 13.8 V		Red (or Pink)
3	CAN N	0 - 5 V		Green
7	GPIO	0 - 5 V		Blue
5	GND	0 V		Orange
4	CAN P	0 - 5 V		Yellow
NA	SHIELD	-	Should be tied to GND on customer end of cable	Purple
NA	SHIELD	-	Cable braid / drain – connected to shield	White – heatshrink wrapped

*Note that there are two black wires on the pigtail end of the cable. However, one is heatshrink wrapped and is not fully insulated at the base where it meets the thick plastic insulation. This is the cable braid / drain of the cable. The black RS-232 TX signal is stripped only at the tip like all the other wires.

The CAN Bus is terminated within the MC1-001 with a 120 Ω resistor. It is recommended that the user provide the appropriate termination within their system which is recommended to be a corresponding 120 Ω resistor on the host end of the system.

The MC1-001 can accept an input voltage from 7 to 13.8 V. Power consumption under steady state is approximately 800 mW. When enabling the LRF the system demands an inrush current for up to 5 ms. When connected directly to a power supply, the current compliance limits shown in Table 9 provided adequate supply current during this inrush period.

Table 9 - Maximum current required at the specified operating voltage to support the inrush current when enabling the LRF

Operating Voltage (V)	Maximum Current (mA)
7	500
10	150
13.8	100

Many electronic component distributors may sell pre-crimped wires of varying lengths and colors if you wish to build your own cable set. Attollo also sells pre-assembled cable assemblies with the DF13 and ODU connectors described above and color coded in accordance with the corresponding pinouts. Attollo sells a USB to UART adapter board for communicating with the WASP-200 LRF over a computer's serial interface. Visit the website for configuration and ordering information.

Communication Interface (CU1 and MU1)

The WASP-200 LRF provides a UART serial interface for communication. The UART communication settings are summarized in Table 10. The following section will provide detail on the command structure used for communicating with the WASP-200 LRF.

Table 10 - WASP-LRF UART communication settings

Specification	Measurement
Baud Rate	115200 & 921600
Data Bits	8
Stop Bits	1
Parity	None
Flow Control	None
Terminating Character	Linefeed (Hex: 0x0A)

All serial commands must append a linefeed character at the end in order to be properly received by the WASP-200 LRF.

Serial Commands

Communicating with the CU1 and MU1 variants of the WASP-200 LRF takes place through the serial command interface using ASCII-based commands. Each command to the LRF consists of an initialization character, a command mnemonic, and zero or more arguments. All commands are case sensitive and are UPPER CASE. The initialization character for all commands being transmitted to the rangefinder is the “>” character. For example:

```
>RNG
```

All serial commands must append a linefeed character at the end (ASCII (hex) 0x0A, ‘\n’) to be received by the LRF.

ASCII responses from the WASP-200 LRF follow a similar format, except the initialization character is the “<” character. The initialization character can also be helpful as a dataflow direction indicator.

At power-on, after the WASP-200 has initialized, it will report it’s model name (MNM), hardware revision (MHV), serial number (MSN), firmware version (MFW), and manufacturer (MFG). Receipt of these responses indicates the WASP-200 is ready to receive commands and begin ranging.

The available commands for use with the WASP-200 LRF are:

AUT	Auto-threshold enable / disable
AUV	Auto-voltage enable / disable
AVG	Number of multi-pulse averages
BAUD	Baud rate of UART interface
CHK (CHKSUM)	Add 16-bit checksum to output
DCM?	Detector dark current
FMT	Output format
FRQ	Continuous ranging frequency
HLTH?	Health check
LBE	Binary output format endianess
LOM	Legacy Output Mode
MDF (MEDF)	Median-filter window size
MFG	Manufacturer
MFW	Model firmware version
MHV	Model hardware version
MNM	Model name

MSN	Model serial number
MVG (MAVG)	Moving average
NSG?	Detector noise
OFS	Range offset in meters
RBF	Reset range buffer
RNG	Single range
RST (RSTB)	Software reset
RUN (GO)	Start continuous ranging
SAV / (SAVE)	Saves current settings to flash
SET (SET?)	Current settings
STP	Stop continuous ranging
THR	Sensitivity threshold
TMP?	System temperature
TOS (TOFS)	Sensitivity threshold offset
TRG (TRIG)	Triggered ranging
VLT	APD bias voltage

Command	ANO	Arguments	[0/XX.X (float)]
Description	Sets the maximum range that is represented by 3.3V output on the DIG_OUT pin. The analog output voltage is proportional to the measured range as a portion of the programmed maximum range. A value of 0 disables the analog output. This functionality is only enabled if the unit is configured for analog output before shipping.		
Example	>ANO 120 < ANO120		

Command	AUT	Arguments	[0/1]
Description	Enables (1) and disables (0) the auto-threshold adjustment. The auto-threshold feature ensures that the system is in its highest sensitivity state, while still ensuring a better than 1% false alarm rate, before every range measurement.		
Example	>AUT 1 < AUT1		

Command	AUV	Arguments	[0/1]
Description	Enables (1) and disables (0) auto-voltage adjustment. Auto-voltage adjustment maintains the sensitivity of the system over changes in the LRF's ambient environment.		
Example	>AUV 0 < AUV0		

Command	AVG	Arguments	[1…32]
Description	Sets the number of pulses to be used in multi-pulse averaging mode. In this mode, a sequence of rapid-fire ranges are taken and then averaged to improve the accuracy of the measurement. Each range operation takes approximately 100 us to complete so the number of averages multiplied by 100 us should not exceed 1/FRQ. The LRF will prioritize maintaining the ranging frequency and will reduce the number of averages taken to remain within compliance with the Class 1 classification.		
Example	>AVG 8 < AVG8		

Command	BAUD	Arguments	[HIGH/LOW]
Description	Sets the baud rate of the UART communication interface. A value of HIGH will set the baud rate to 921600 bps and a value of LOW will set the baud rate to 115200 bps. Baud rate changes will take effect upon issuance of the command.		
Example	>BAUD HIGH		

Command	CHK (CHKSUM)	Arguments	[0/1]
Description	Enables (1) and disables (0) the reporting of a checksum with every range report. The checksum is calculated as 16-bit with a polynomial of 1021 and an initial value of 0. When enabled, the range response will look like the following: < 10.145d| < 10.459ô+ < 11.074ú* < 11.089N0 < 11.104ÑÂ		

	where the two bytes after the 3 decimal point precision range response represent the binary-encoded checksum.
Example	>CHKSUM 1 < CHKSUM1

Command	DCM?	**Arguments**	None
Description	Reports the current detector dark current value in arbitrary units.		
Example	>DCM? < DCM?312		

Command	FMT	**Arguments**	[BINARY/ASCII]
Description	Sets the output format for range reporting. ASCII will report range data as a 3 decimal precision floating point number. BINARY will report range data as a 32-bit floating point number. Regardless of the output format mode, the WASP-200 LRF always expects inputs in ASCII format.		
Example	>FMT BINARY < FMT BINARY		

Command	FRQ	**Arguments**	[1…56]
Description	Sets the repetition frequency of the ranging operation in Hertz. XXXX is the desired frequency of operation. Upon entering the desired frequency, the system will calculate the nearest frequency that it can handle according to the U.S. FDA Laser Classification of the product and/or resolution of internal timers. This value will be reported back to the user. The frequency can be set / changed within this frequency range when the system is either active or idle. To remain Class 1 compliant, the LRF must never exceed 56 laser pulse outputs within a 1 second time period. Therefore, if the averaging function is being used, where the LRF sends out a burst of pulses and averages the results, the LRF will prioritize maintaining the ranging frequency and will reduce the number of averages taken to remain within compliance with the Class 1 classification.		
Example	>FRQ 50 < FRQ50		

Command	HLTH?	**Arguments**	None
Description	Reports a summary of various health aspects of the rangefinder including dark current, temperature, noise level, whether ranging is presently active, and any current system errors.		
Example	>HLTH? < DCM?0 | TMP?024.82 | NSG?5280 | ACT?0 | ERR?0		

Command	LBE	**Arguments**	[BIG/LITTLE]
Description	Sets the endian-ness of the BINARY output during range reporting. LBE has no effect when the output format is ASCII. The default endian-ness is BIG.		
Example	>LBE LITTLE < LBE LITTLE		

Command	LOM	**Arguments**	[0/1]

Description	Sets the output formatting to that of the early version of the wasp with a line break before the range result for the RNG command and no carrots on each line of range results for the RUN command
Example	>LOM 1 < LOM1

Command	MDF (MEDF)	**Arguments**	[1…32]
Description	Sets the window size for the real-time median filter. When MDF is greater than 1 the median filter is active.		
Example	>MDF 8 < MDF8		

Command	MFG	**Arguments**	None
Description	Reports the manufacturer of the WASP-200 LRF.		
Example	>MFW < MFW ATTOLLO ENGINEERING		

Command	MFW	**Arguments**	None
Description	Reports the WASP-200 LRF firmware version.		
Example	>MFW < MFW 18410001		

Command	MHV	**Arguments**	None
Description	Reports the hardware revision of the WASP-200 LRF.		
Example	>MHV < MHV 100		

Command	MNM	**Arguments**	None
Description	Reports the model name of the WASP-200 LRF.		
Example	>MNM < MNM CU1-001		

Command	MSN	**Arguments**	None
Description	Reports the serial number of the WASP-200 LRF.		
Example	>MSN < MNM 18380007		

Command	MVG (MAVG)	**Arguments**	[1…64]
Description	Sets the number of historic range results to use for calculating the current range result. When MVG is greater than 1, the current range result will be the current measured value averaged with the N-1 previous results.		
Example	>MVG 10 < MVG10		

Command	NSG?	Arguments	None
Description	Reports the current system noise in arbitrary units.		
Example	>NSG? < NSG?64		

Command	OFS	Arguments	[-10.0…10.0]
Description	Applies an offset to the reported range. Valid arguments can be negative or positive floating point numbers.		
Example	>OFS 0.23 < OFS0.230		

Command	PWM	Arguments	[0/1/2]
Description	Enables PWM range output on the DIG_OUT line. When enabled, each range will cause the DIG_OUT line to go high for a time that is proportional the range according to the user defined resolution. Once the DIG_OUT line has been high proportional to the amount of time that represents the range, it will remain low until the next range even occurs. A parameter value of 0 will disable PWM output, 1 enables PWM output with a high time of 1 ms / m, and 2 enables PWM output with a high time of 0.1 ms / meter.		
Example	>PWM 1 < PWM1		

Command	RBF	Arguments	None
Description	Resets the range buffer. The range buffer is a 64-element queue of the last 64 ranges that is used for carrying out the moving average (MVG) and median filter (MDF) functions. Resetting the range buffer may be useful if the user suspects that stale range data may be in the queue (i.e. there was a break in the ranging while the vehicle was still moving) and the user wishes to use the moving average or median filter.		
Example	>RBF < RBF		

Command	RNG	Arguments	None
Description	Executes a single shot range operation and returns a single range result. The range result is reported according to the formatting options selected using the FMT and LBE commands. Assuming ASCII formatted output (FMT ASCII) the range result will be a floating point number with 3 decimal points of precision. **All ranges are referenced from the rear of the unit.** The OFS command can be used to apply an offset to this reference datum. The RNG command can be called sequentially and will limited to 56 Hz. Exceeding this rate will result in a “RANGE_NOT_READY” error code (-6).		
Example	>RNG < 5.832		

Command	RST (RSTB)	Arguments	None
Description	Conducts a software reset of the WASP-200 LRF.		
Example	>RST		

Command	RUN (GO)	Arguments	None
Description	Starts continuous ranging at the frequency specified by FRQ. The range results will be reported in the format specified by the FMT and LBE parameters. By default, the range result is reported as plain text ASCII floating point number with 3 decimal places of resolution.		
Example	>RUN < RUN		

Command	SAV (SAVE)	Arguments	None
Description	Saves all currently active user parameters to the non-volatile flash memory. The WASP-200 LRF will re-load these parameters after the next software or power-on reset. The currently active user parameters can be viewed using the SET command.		
Example	>SAV < SAV		

Command	SET (SET?)	Arguments	None
Description	Reports the current system parameters.		
Example	>SET < THR220 TOFS0 OFS0.000 FRQ10 VLT677 AVG1 MAVG1 AUT1 AUV1 MEDF1 LBE|BIG FMT|ASCII CHKSUM1 TRIG0 SAVE1		

Command	STP	Arguments	None
Description	Stops continuous ranging.		
Example	>STP < STP		

Command	THR	Arguments	[1…255]
Description	Sets the system sensitivity. Larger values of THR represent higher sensitivity. When in auto-threshold mode the system will control the value of THR to prevent excessive false alarm rates based on settings made at the factory. The maximum system value is 255.		
Example	>THR 240 < THR240		

Command	TMP?	Arguments	None
Description	Reports the current system temperature in degrees Celsius.		
Example	>TMP? < TMP? 35.44		

Command	TOS (TOFS)	Arguments	[-10…10]
Description	Applies an offset, positive or negative, to the sensitivity threshold (THR) of the rangefinder. The offset only applies in auto-thresholding mode (AUT1) and is ignored when in manual thresholding mode (AUT0). Care should be taken such that the sum of TOS and the present THR (without offset applied) value does not exceed 255 or does not subceed 0, otherwise undesirable behavior may occur.		

	Typically, useful offset values are small (i.e. absolute value of 1 to 3) and may be used to improve sensitivity at the expense of a higher false alarm rate or to counteract a strong sunlight on particularly reflective or specular target.
Example	>TOS 2 < TOS2

Command	TRG (TRIG)	**Arguments**	[0/1]
Description	Enables (1 or 2) and disables (0) the external range triggering via the DIG_IN pin. A value of 1 enables rising edge triggered ranging and a value of 2 enables falling edge triggered ranging. The minimum pulse width in either case must be greater than 1 µs. The active edge rate must not exceed the maximum range rate of the rangefinder otherwise a RANGE_NOT_READY error will be reported and the request will be ignored.		
Example	>TRG 1 < TRG1		

Command	VLT	**Arguments**	[0…1023]
Description	Sets the APD bias, in arbitrary units. Upon power-up, the system will automatically set the APD bias and continue to adjust it depending on varying ambient conditions and it should not need to be further adjusted. However, VLT gives the user the ability to change the bias. Increasing the bias too far past the start-up value risks over-biasing the APD and causing permanent damage to the APD. You must disable auto-voltage adjustment (AUV 0) before setting the voltage using the VLT command.		
Example	>VLT 510 < VLT510		

Range Error Codes

Range error codes are reported by the WASP-200 LRF by a "-" sign followed by a code instead of the expected range value.

Table11 – WASP-200 LRF UART ERROR Codes

Error	Error Code	Description
RANGE_NULL	-1	No range received from target.
RANGE_MAVG_BUFFER_NOT_FULL	-2	Moving average buffer has not been filled yet.
RANGE_AVG_NULLS	-4	50% or greater of the averaged pulses were NULLs
RANGE_MAVG_BUFFER_NULLS	-5	50% or greater of the ranges in the moving average buffer are NULLs
RANGE_NOT_READY	-6	LRF not ready for range request. Range requested in excess of maximum allowable range rate (i.e. 56 Hz for Class 1 operation)

Communication Interface (MC1)

The WASP-200 MC1 LRF has both a CAN interface and an RS-232 serial interface. The CAN interface is formatted according to the CAN 2.0B standard and is configured to be compliant with the Latitude AGL-M/N communication protocol and therefore compatible with the Cloud Cap Technologies Piccolo autopilot. The baud rate of the CAN channel is 1,000,000 bps.

Similarly, the RS-232 interface is designed to be compliant with the Latitude AGL-M/N communication protocol and therefore compatible with the Cloud Cap Technologies Piccolo autopilot. The baud rate of the RS-232 channel is 9,600 bps. Note that unlike the UART versions of the WASP-200 LRF (CU1 and MU1), no terminating character is used for the Piccolo-compatible RS-232 interface.

The RS-232 interface also provides a passthrough mode, accessible through the use of the "LRF" command, which can be used to issue the serial commands described in the previous section to the underlying WASP-200 LRF. This is useful for configuring the LRF for utilize more advanced filtering modes when being utilized via the Piccolo command protocol. For instance, the LRF can be configured for moving average or multi-pulse filtering when in use with the Piccolo autopilot.

CAN

The CAN frame is formatted as shown in Table 11.

Table 11 - CAN Frame Structure

Field	Name	Description
0	29-bit identifier	See Table 12 for field description
1	Control	Contains the data length
2	Data	Up to 8 data bytes
3	CRC	CRC sequence
4	ACK	Ack field

The 29-bit identifier bits are broken down into the fields shown in Table 12.

Table 12 - CAN 2.0B Frame Identifier

Bits	0:4	5:12	13:28
Field	Group ID	Message ID	Serial Number. Use "0" for "all broadcast"

CAN Bus Commands

The CAN commands are nearly a complete subset of the Latitude Engineering AGL CAN command set (Title: AGL-Comms-Interface, Dated: 12/15/15). This allows the WASP-200 MC1-001 to be a drop-in replacement, communication-wise, with the Cloud Cap Technology Piccolo family of autopilots. The supported commands are listed in Table 13 and a description for the CAN group IDs are shown in Table 14.

Table 13 -WASP MC1-001 Data Packet Types

Name	CAN Group ID	Message ID	Description	Direction
READING	0x04	0x00	Contains the data from a single reading	Down
LASER_MODE	0x04	0x01	Sends sensor setting information to the LRF	Up

SINGLE	0x04	0x02	Requests a single range reading	Up
LASER_MODE_2	0x04	0x03	Sends sensor setting information when requiring range rates in excess of 20 Hz	Up
CONFIG	0x15	0x0C	System configuration and user settings	Up
POWER	0x04	0X0E	Controls the ON/OFF state, allows testing, and sets the startup behavior	Up
EXT_POWER	0x15	0x0E	Controls ON/OFF state via Piccolo uplink	Up
UPDATE_OFFSET	0x04	0x1F	Updates the laser offset calibration	Up
DATE_VERSION	0x04	0xFF	Sends the firmware version and build date	Up/Down

Table 14 - CAN Group IDs

Group ID	Name	Description
0x04	AGL Output	Used for message I/O via the Piccolo External Sensors protocol
0x14	Piccolo Downlink	Used for messages from the AGL Sensor via the Piccolo downlink
0x15	Piccolo Uplink	Used for messages to the AGL Sensor via the Piccolo uplink

CONFIG

This packet allows the user to specify general system settings. Since this packet has the potential to conflict with other devices on the CAN bus by using the general Piccolo uplink group ID (0x015), a unique identifier has been embedded into the message to help distinguish it from others. The unique identifier is 0x1A5.

Table 15 - CONFIG packet byte structure

Byte	Name	Description
0	Flags	8-bit flags Bit 0 (MSB): Enable raw laser reading output over CAN bus - **Not used; Always '0'** Bit 1: Reserved Bit 2: Reserved Bit 3: Reserved Bit 4: Reserved Bit 5: Reserved Bit 6: Reserved Bit 7: Reserved
1	Flags	8-bit flags Bit 0-7: Reserved
2	AGL ID0	0x1A (unique identifier)
3	AGL ID1	0x5E (unique identifier)

READING

Table15 - READING packet byte structure

Byte	Name	Description
0	Flags	8-bit flags Bit 0 (MSB): Reading is bad Bit 1: Accuracy exceeds limit – **Not used; Always '0'** Bit 2: Reading is high resolution, else low – **Not used; Always '0'**

		Bit 3: Nearest Target mode - **Not used; Always '0'** Bit 4: Furthest Target mode - **Not used; Always '0'** Bit 5: Max range multiplier (0 = 5 meters; 1 = 100 meters) Bit 6: Time multiplier (0 = 50 ms; 1 = 10 ms) Bit 7: Reserved
1	Altitude	24-bit unsigned laser range in millimeters
2		
3		
4	Period	Indicates the period of the measurement, units indicated by the time multiplier bit.
		Special Cases:
		0x00 | Period is out of range or unknown
5	Latency	Unsigned integer; indicates the latency of the measurement. Set to '0x00' as the time from measurement to CAN message transmission is less than 1 ms.
6	Accuracy	Unsigned integer; Un-used. Set to '0x00'
7	Max Range	Unsigned integer; the maximum useable range of the sensor in 5's or 100's of meters, depending on the state of the Max Range bit in the Flag byte.

LASER_MODE & LASER_MODE_2

This packet will set the laser's mode. This state is remembered through a power cycle.

Table 16 – LASER_MODE packet byte structure

Byte	Name	Description
0	Flags	8-bit flags Bit 0 (MSB): Set continuous readings on ('1') or off ('0') Bit 1: Nearest target mode - **Not used; Always '0'** Bit 2: Farthest target mode - **Not used; Always '0'** Bit 3-7: Reserved
1	Period	Indicates desired period of the measurement, in **50 ms** units. A value of 5, for example will result in a measurement period of **250 ms** or **4 Hz**. This allows measurement periods from **50 ms (20 Hz)** to **12.75s**. If longer measurement periods are required, use the SINGLE packet to take individual readings.
		Special Cases:
		0xFF | No change to current period setting

In order to request range rates in excess of 20 Hz the LASER_MODE_2 packet should be used.

Table 17 – LASER_MODE_2 packet byte structure

Byte	Name	Description
0	Flags	8-bit flags Bit 0 (MSB): Set continuous readings on ('1') or off ('0') Bit 1: Nearest target mode - **Not used; Always '0'** Bit 2: Farthest target mode - **Not used; Always '0'** Bit 3-7: Reserved

1	Period	Indicates desired period of the measurement, in **10 ms** units. A value of 5, for example will result in a measurement period of **50 ms** or **20 Hz**. This allows measurement periods from **10 ms (100 Hz)** to **2.55s**. If longer measurement periods are required, use the SINGLE packet to take individual readings.	
		Special Cases:	
		0xFF	No change to current period setting

POWER & EXT_POWER

This data packet is used to turn the laser power on and off and, optionally, set the initial power-on behavior. Since this packet has the potential to conflict with other devices on the CAN bus by using the general Piccolo uplink group (0x15), a unique identifier has been embedded into the message to help distinguish it from others. The unique identifier is 0x1A5.

The Piccolo will periodically send this message at the appropriate phases of flight to control the on/off state of the laser.

Table 18 – POWER & EXT_POWER packets byte structure

Byte	Name	Description
0	Power Flags	8-bit flags Bit 0 (MSB): 1: Turn Power On; 0: Turn Power Off Bit 1-7: Reserved, set to 0
1	Behavior Flags	8-bit flags Bit 0 (MSB): 1: Set this message's behavior as default power-on behavior (only applies to Byte 0, bit 1); 0: No change Bit 1-7: Reserved, set to 0
2	AGL ID0	0x1A (unique identifier)
3	AGL ID1	0x5E (unique identifier)

NOTE: Specific power-on behavior may be required to satisfy laser safety requirements. External interfaces used during day-to-day operations should not alter this setting.

SINGLE

This data packet is used to request that the laser take a single measurement, using the mode settings already in memory. If sent while the laser is in continuous mode, the unit will return an extra measurement between the normal period, if time allows, and then resume the continuous readings.

Table 19 – SINGLE packet byte structure

Byte	Name	Description
0	Request	'0x05' – Requests the AGL sensor to take a reading and return a single READING packet

UPDATE_OFFSET

This data packet is used to update the unit's unique, manufacturer specified laser offset value. As this value is supplied by the manufacturer and calibrated at the factory, this packet is not intended to be used by the end user.

Table 20 – UPDATE_OFFSET packet byte structure

Byte	Name	Description

0	OFFSET_0	1st byte of the unsigned 16-bit integer representing the factory calibrated offset in millimeters which is added to the laser measurements. This offset is a product of the calibration process and is unique to the laser within each unit.
1	OFFSET_1	2nd byte of the aforementioned unsigned 16-bit integer.

DATE_VERSION

This packet sends the firmware version, build date, and the hardcoded offset.

Table 21 – DATE_VERSION packet byte structure

Byte	Name	Description
0	Major Version	The 1 in 1.2.3
1	Minor Version	The 2 in 1.2.3
2	Sub Version	The 3 in 1.2.3
3	Date month	
4	Date day	
5	Date year	For 2018, the value will be 18
6	OFFSET_0	1st byte of the unsigned 16-bit integer representing the factory calibrated offset in millimeters which is added to the laser measurements. This offset is a product of the calibration process and is unique to the laser within each unit.
7	OFFSET_1	2nd byte of the aforementioned unsigned 16-bit integer.

The DATE_VERSION packet can be requested by sending a packet with the DATE_VERSION packet type, a size byte of 0, and no data bytes.

RS-232

All RS-232 communications take place using packets whose general format is described in Table 22. Note that all multi-byte values are always sent with the most significant byte first, i.e. in Big-Endian order. This document identifies the bit order of a word as starting at 0 which is the left-most or most-significant bit (MSB).

Table 22 - RS-232 datalink layer packet definition

Byte	Name	Description
0	SYNC1	First synchronization character used to signal the receiving state machine that a packet may be forthcoming. Must be 0xFF.
1	SYNC2	Second synchronization character used to signal the receiving state machine that a packet may be forthcoming. Must be 0x5A.
2	PktType	The packet type. i.e. Message ID.
3	Size	Number of data bytes in the packet.
4…Size+3	Data	Data of the packet
Size+4	Check_0	Most and least significant bytes of the Fletchers checksum. The checksum is formed from byte 0 up to and including the last data byte
Size+5	Check_1	

RS-232 Pass-Through Commands

The RS-232 interface can be used to access the rangefinder settings and parameters associated with the WASP-200 MC1 with the use of the “LRF” command. This allows the user to configure with customized settings like multi-pulse averaging, fixed threshold, etc. which are features that are not accessible via the Piccolo interface.

LRF

This command sends an LRF command, according to those listed the Serial Commands section of this manual. The user may use the LRF command to set the number of averages, set the median filter window size, etc. which will be utilized when requesting range information via the CAN interface.

The following commands should not be used in conjunction with the LRF command as they may cause the MC1-001 to stop communicating properly:

FMT
BAUD
CHK
TRG

An example of usage of the LRF command is:

```
>LRF SET
< THR220 TOS0 OFS0 FRQ4 VLT698 AVG1 MVG1 AUT1 AUV1 MDF1 LBE|BIG FMT|ASCII CHK0 TRG0 SAV1
```

Use with Cloud Cap Piccolo Autopilot

Simply install the MC1-001 LRF. The default settings enable the CAN message output in continuous mode, which will be recognized and utilized by the Piccolo with no additional settings necessary.

Revision History

Version	Date	Comments
001	2018-05-16	Initial version
002	2018-10-15	FDA Laser Compliance approval updates
003	2018-11-21	Update to version command formatting, RANGE_NOT_READY error code added. Added CHKSUM and TRIG commands. Note in introduction regarding 10 kHz only applying to Class 3 operation. Not available in Class 1 product.
004	2018-12-20	Combining Commercial Version with CAN Bus Version into One User Manual Added commands associated with 18500001 Firmware Update.
005	2018-12-21	Made TLA command deprecation consistent throughout documentation Corrected examples Added LOM command
006	2019-04-18	Added documentation supporting Collins Aerospace / CloudCap Piccolo RS-232 interface Updated LRF passthrough example to explicitly show linefeed Updated Table 6 & 8 - correct wire colors from Grey to Green.
007	2020-04-28	Updated Company Address Updated Fig. 2 – FDA Label Updated Table 8 – correct Shield wire colors from Black to White Custom Commands – ANO, PWM Filtered False Alarm Detection Section