

**Operators Manual for the BMT160KS
Series Turbine Engine
TCU V2.06**

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Introduction to the BMT160-KS

Design:

The BMT160-KS is an advanced development based on the very latest state of the art in Model Gas Turbine Engines. It follows the classic design of Single Radial Compressor and single Axial Turbine. The combustor is annular in shape and utilizes a low pressure fuel vaporizing system. Starting is accomplished by a micro-engineered fuel atomizer allowing direct and safe starting on the main fuel supply. NO GAS is required for starting. The precision ground main shaft is supported by two high speed hybrid ceramic ball bearings.

Materials:

All materials used in the construction of the BMT160-KS are of the highest quality. The compressor wheel is a custom designed unit. All aluminum components are aerospace grade and the main shaft is ground from high stability heat treated tool steel. The main shaft tunnel is ultra precision machined from a special grade of Stainless Steel. While this carry a small weight penalty it overcomes the heat expansion ratio mismatch that occurs with aluminum shaft bearing supports which carries the penalty of sudden bearing failures under extreme heat conditions. All fixing screws are Stainless Steel. The Turbine and Nozzle Guide Vane (NGV) are cast in Inconel 713 using the lost wax process and processed in Vacuum Induction Furnaces to ISO9001 quality control levels. The outer housing is manufactured in one seamless unit from stainless steel sheet and is precision CNC finished to very tight tolerances and results in a 150g weight saving over our previous system.

Electric Starter

The BMT electric starter is a thoroughly engineered unit. The main shaft of the starter driver is independently supported using a thrust ball race and radially supporting needle roller bearing. The electric motor within the starter is of the SPEED 400 type and is not subject to thrust and radial loading from the main starter shaft. While this results in a slightly longer assembly, it has a service life of more than 5000 starts and can sustain the turbine without problem at up to 30 000 RPM. In real terms it is limited to drive up to 20 000 RPM. The electrical connection to the starter is contained within the mounting struts. The unit is factory sealed and has no external screws or components.

Technical Data BMT160-KS

Diameter	108mm (4.25")
Length	245mm (9.6") excl starter 320mm (12.6") incl. starter
Engine weight	1450g including starter (2.9 lbs.)
Auxiliary equipment	320g (11 ounces) includes TCU + Pump + Battery
Fuel	Jet A1 or K1 Kerosene
Lubrication	Aeroshell 500 or EXXON 2380

Performance Data BMT160-KS

Thrust @ 125 KRPM	158 Newton's (33.6 lbf)
Thrust @ 35 KRPM	5 Newton's (1 lbf)
Max RPM	135 000

Min RPM	30 000
Idle RPM	34 000
EGT	675 deg C
Ambient operating limits	5 deg C to 45 deg C

Fuel Pump:

The electric Fuel Pump is a precision gear type displacement pump with 2 barbed fittings.

Diameter 25mm x 44mm long (1" dia x 1.75" long)

Weight: 60 grams (2 ounces)

Electronics:

The electronics of the BMT160-KS is state of the art and manufactured under ISO9001 quality control levels. Extensive use is made of SMD technology to improve reliability. The hardware and software has been developed by André Baird, an experienced modeler and jet pilot with many hours of experience in turbine operation and flying. Noteworthy features not found on other systems are the integrated charger for pump battery and other NiCad or Metal Hydride cells i.e. RX battery. While the TCU powers up automatically via its optical sensing system when the RX system is powered, it can also be powered independently without the RX system being powered by simply plugging in the GSU. Similarly, removing the GSU powers down the TCU automatically when the RX system is not powered. The GSU can be removed from the 12V supply to be used as a fully portable instrument right up to the flightline.

Turbine Control Unit (TCU)

The TCU uses an advanced microprocessor and sophisticated software. It acts as the throttle of the engine. It uses a four cell 4.8 Volt NiCad battery back of 2400 mAh. The TCU does not utilize RX battery power as it is optically isolated. It can regulate a constant 5V for its internal working from pump battery voltages between 3 and 9 Volt and is therefore immune from battery voltage fluctuations. Because of the opto isolation from the RC system and general good design practice, the BMT TCU will not contribute any significant amount of RF noise to the RX.

TCU Features:

40 MHz CPU with 64K of reprogrammable code memory.

Internal 2K eeprom data memory.

Internal 1K data RAM.

External 32K eeprom datalogging memory.

8 channel 12 bit Analog to Digital converter.

Switching power supply allows wildly fluctuating battery voltages as low as 2.4 Volt.

Integrated real time clock with 10 Year battery backup.

All connectors are integrated into the unit to eliminate cable clutter in the airframe.

Two external servo leads of JR type connects to RX.

No external switch required, TCU powers up when RX is turned on and/or GSU is plugged in.

Inputs:

1. RPM sensing using ultra reliable magnetic pickup
2. Temperature sensing using type "K" thermocouple.
3. Pump RPM feedback.
4. Pump Battery voltage input.
5. RX Battery voltage input (opto Isolated).
6. Throttle demand input (opto isolated).
7. Auxiliary (Starting/Shutdown/Smoker) channel input (opto isolated).
8. Airspeed sensor. (Optional)

Outputs:

1. PWM output to pump.
2. PWM output to Smoker Pump.
3. Starter driver.
4. Gloplug driver
5. Fuel valve driver
6. Injector driver.
7. RJ45 connector and cable for Turbine functions.
8. RJ45 RS232 output/input to Ground support.

TCU Dimensions:

ABS case 70 x 50 x 25 mm (2.75" x 2" x 1") Weight: 60 grams (2 ounces)

TCU Operation:

All aspects of turbine operation is controlled by the TCU based on normal parameters "mapped" during programming. Deviations from these are corrected and should operational parameters not return to normal within a specified time span, power is reduced to a level where emergency parameters are allowed to continue operation of the turbine if possible, otherwise the main fuel valve is shut.

Important: The pilot has the option to shut down the engine at any time by moving the start/shutdown channel switch to SHUTDOWN or closing the throttle with the idle trim lever down. We do not recommend R/C systems using electronic trim on the throttle channel.

Pump Battery:

The BMT pump battery supplied is a 4 cell Sintered NiCad battery specified to provide the necessary starter current for the standard length power cable. The user may substitute a higher capacity or lower capacity battery if required for a particular installation in consultation with BMT. A 5 cell pack may be used in models requiring a particularly long starter power cable. The BMT TCU and GSU requires no adjustments when using different amounts of cells. Lithium Ion cells (Duralites) are not suitable for this high current application.

Battery specification:

2400mAH 4.8V Sanyo SCR cells.
Size: 90mm x 46mm x 24 mm. (3.5" x 1.8" x 0.95")
Weight: 200 grams (7 ounces)

Ground support unit:

The GSU provides the means by which the user can access the many features within the TCU. It also provides the charging current for the pump battery when plugged into a 12V source. The GSU acts like a dumb terminal for the TCU. For this reason it will probably never need to have a software upgrade.

GSU Features:

1. 32 character high contrast STN LCD Display
2. Start button for automatic startup.
3. Shutdown button.
4. Abort start button.
5. Full 20 key keypad for easy navigation of menu tree and functions.
6. Integrated Rapid charger for pump NiCad and RX battery via optional adapter.
7. 20 MHz CPU with 20K of reprogrammable code memory.
8. 8 channel 12 bit Analog to Digital converter.
9. Monitors charging current and input/output voltages.
10. Software adjustable charging current.
11. Can operate independently from 3 – 18 volts from either TCU or 12V Source.
12. Can be carried around easily to the flight line.
13. “Molex” style connector for 12V source quickly disconnects for portability.
14. Connects to TCU via RJ45 connectors on either end using 8 way flatcable.

NOTE: The GSU may be used to charge your RX Nicad battery pack independently. Refer to section **“GSU CHARGING”** for details.

Operating the Turbine

Model Gas Turbine engines are precision instruments that require a good deal of care in handling. Because of the high rotational speeds, temperatures and energy levels contained within the engine, a certain level of expertise is required to operate the engine safely. Please study this manual carefully before operating the turbine. Should you feel uncertain about any aspects do not attempt to operate the turbine. Contact your dealer or Baird Micro Turbines directly for advice. See our website at www.bairdtech.com/bmt for details of your nearest service agent.

Preparing to operate the engine for the first time

Familiarize yourself with all the individual components of the engine and their respective functions. Study the connection diagrams of the electronic system in figure 1 and fuel system (figure 2 – figure 5).

You will need a test stand to mount the engine so as to first familiarize yourself with the operational characteristics of the engine. You will need at least one assistant to man a fire extinguisher of the Halon or Carbon Dioxide type. Never fuel or start the engine without a fire extinguisher. Be sure your assistant is also familiar with the operation of the turbine. Absolutely no smoking or open flames within 15 Metres.

Warning: Serious injury may result should any bystander extend a hand closer than two feet to any part of the turbine whilst running. Any object, hand or finger can be

sucked into the inlet within milliseconds. Do not touch any part of the turbine after or during running as serious burns may result from hot metal parts or exhaust gas. Serious eye injury may result if looking into the rear of the motor whilst running due to dust and other particles being accelerated at high velocity.

Fuel preparation

We recommend you use Jet A or Jet A-1 only. Where unavailable K1 Kerosene may be substituted. The BMT160-KS uses part of the fuel supply to lubricate the bearings. To enhance the lubricating capability of the fuel, 5% of Aeroshell 500 or equivalent turbine oil must be added to the fuel. We do not recommend 2 stroke synthetic oils. Extended endurance tests has shown a reduction in bearing life of more than 50%. Documented engine runs of 100+ flights and 600 starts over a period of more than a year in each case, has shown no significant wear in either bearings when using Aeroshell 500. Over the same period 2 stroke oils as recommended by some turbine manufacturers have shown premature rear bearing wear after the same number of operations. While this wear was not excessive and the bearing was still serviceable it is clear that a substantial increase in wear can be expected when using any other oil than that recommended by BMT.

Ignition Source

The BMT160KS uses a regular glow plug. We use the ROSSI #7 or #8 plug. Should you ever need to replace the plug you will need to modify the new plug. The filament wire needs to protrude from the plug bottom at least 2mm. Pull the wire carefully with thin tweezers or a pin. See figure 6 for details.

Take care not to damage the exposed filament when replacing the plug into the engine.

Bystanders and other safety issues.

Turbines are spectacular machines and will probably draw a lot of attention. Please ensure that bystanders are never closer than 5 yards to the engine, especially small children. The area immediately behind the engine should be clear. All objects and articles of clothing should be kept well away from the intake as powerful suction will cause ingestion of loose objects within milliseconds. Always wear hearing protectors when operating an unenclosed engine. The high frequency of induction noise is harmful when exposed to for extended periods. A severe headache is the result even after a short run. However, due to the frequency content this noise quickly diminishes when enclosed or with increasing distance.

Setting up the TCU

Setting up of the TCU is done by pressing "Menu" on the GSU whilst plugged into the TCU. The RX system needs to be powered up as well.

The menu has the following items. View options by scrolling up and down using the <UP> and <DOWN> arrow keys. To execute an option press <E> (Enter):

NOTE: Faster navigation of the main menu options are possible using the "hotkey" method. For example: To go directly to the fast charging option press <MENU> followed by <4> and <E>. This works for options 1 through 9 with '0' invoking TEST INJECTOR

1. SETUP THROTTLE
2. SET SWITCH MODE
3. ADJUST GLOWPLUG
4. FAST CHARGE BATT
5. SLOW CHARGE BATT
6. SET MAX AIRSPEED
7. SETUP SMOKER
8. SET DATE/TIME
9. DO COOLDOWN
10. CLEAR ERROR
11. LOAD DEFAULTS
12. TEST FUEL PUMP
13. TEST INJECTOR
14. TEST STARTER
15. LUBE BEARINGS
16. SET MAX RPM
17. SET PITOT GAINS
18. SET LOGGING RATE

SETUP THROTTLE:

This option sets the throttle range for your particular Transmitter.

When "SET THROTTLE MAX " is displayed on the LCD set your TX throttle stick to the full power position and press ENTER.

When "SET THROTTLE MIN" is displayed on the LCD set your TX throttle stick to idle position and throttle trim in the center position. Press ENTER.

Exit the menu by pressing <C> and check that the display reads "THROT: 1" at idle position and THROT: 100 at full power position. When setting the throttle stick to idle and trim lever down, the display should read "THROT: 0". This is the position where the turbine would be shut down. If the display does not show "0" you may have to increase your throttle trim range.

In the event that your throttle endpoints are too close together the message:

"RANGE < 800 MS! ADJUST ENDPOINTS" will be displayed. Adjust the endpoints accordingly and re-enter the settings. The actual pulse width of your throttle channel is displayed in milliseconds on the LCD screen for your convenience

PS: There is no setting of reverse switches necessary with the BMT controller.

SET SWITCH MODE

This option allows the user to select the starting, shutdown and smoker activation mode that most suits his personal preference. All of these mode options are available through the auxiliary input channel. This channel should be either a 3 position switch or a 2 position action toggle switch, i.e. spring loaded to always return to the "off" position. Note that while scrolling through the mode options by using the UP and DOWN keys, an asterisk (*) character will denote which mode is currently active. Pressing <E> on another mode dialog screen will render it active. The menu will then proceed to prompt you to setup the switch itself. Pressing <C> will return to the main menu tree.

Important: Before selecting your preferred mode first carefully study the different modes:

MODE 1:

"<A>=START=OFF <C>=STOP"

Description: Requires a 3 position switch action. The center position "" is the inactive position i.e.. "OFF". Moving the switch to <A> will initiate the autostart sequence. Returning the switch to the center position will not interfere with the startup sequence. Moving the switch to <C> will shutdown the engine immediately, where after a cooldown cycle will be initiated. Thereafter another autostart sequence may be initiated.

MODE 2:

"<A>=START/STOP =OFF"

Description: Requires a 2 position switch action. The position "" is the normal position i.e.. "OFF". Moving the switch to <A> will initiate the autostart sequence. Returning the switch to the normal position will not interfere with the startup sequence. Moving the switch to <A> again will shutdown the engine immediately, where after a cooldown cycle will be initiated. Subsequent switch actions will be ignored until the cooldown cycle is completed. Thereafter another autostart sequence may be initiated.

MODE 3:

"<A>=START =OFF "

Description: Requires a 2 position switch action. The position "" is the normal position i.e.. "OFF". Moving the switch to <A> will initiate the autostart sequence. Returning the switch to the normal position will not interfere with the startup sequence. Subsequent switch actions will be ignored until the turbine has been shutdown via either the GSU or the throttle stick was moved to the idle position with the trim lever down and the cooldown cycle is completed. Thereafter another autostart sequence may be initiated.

MODE 4:

"<A>=START/SMOKE =OFF"

Description: Requires a 2 position switch action. The position "" is the normal position i.e.. "OFF". When the turbine is not running moving the switch to <A> will initiate the autostart sequence. Returning the switch to the normal position will not interfere with the startup sequence. Once the Turbine RPM exceeds 80 000 and the EGT exceeds 450 deg C, the switch will behave as follows:

Moving the switch to <A> for a short blip (1 – 2 seconds) will switch the smoker pump ON.

Moving the switch to <A> once more for a short blip (1 – 2 seconds) will switch the smoker pump OFF

Moving the switch to <A> and holding it there will switch the smoker pump ON at the normal pump power. After 2 seconds the smoke pump power will be reduced slowly to zero and then increased again to the maximum value programmed. Releasing the switch at any point will set the normal pump value to that at the time the switch was released. This setting will remain and is saved in non-volatile memory until reset by the same action.

Should the Turbine RPM drop below 80 000 or the EGT drops below 450 deg C the smoker pump will be turned off, regardless of the switch position. When the turbine has been shut down via either the GSU, or the throttle stick was moved to the idle position with the trim lever down, and the cooldown cycle have been completed, another autostart sequence may be initiated.

MODE 5:

"<A>=START/CRUISE =OFF "

Description: This mode allows you to engage cruise control and use the autostart option via the switch channel. Requires a 2 position switch action. The position "" is the normal position i.e.. "OFF". When the turbine is not running moving the switch to <A> initiates the autostart sequence. Once the autostart sequence has completed and the THROT: position exceeds 50 and the minimum airspeed of the aircraft exceeds 50Mph (80 Km/h) the switch will behave as follows:

Moving the switch to <A> for a short blip (1 – 2 seconds) will engage cruise control at the current speed of the aircraft
Moving the switch to <A> once more for a short blip (1 – 2 seconds) will disengage cruise control.

NOTE: Cruise control is also automatically disengaged when moving the throttle stick to less than 50. Function inactive with "SET MAX AIRSPEED" disabled.

MODE 6:

"<A>=START/SMOKE =OFF <C>CRUISE"

Description: This mode combines all of the functions available in one. The Smoker and Cruise control as well as the autostart option can be selected via the switch channel. Requires a 3 position switch action. The position "" is the normal position i.e.. "OFF". When the turbine is not running moving the switch to <A> initiates the autostart sequence. Once the autostart sequence has completed, the switch will behave as follows:

Once the Turbine RPM exceeds 80 000 and the EGT exceeds 450 deg C, moving the switch to <A> for a short blip (1 – 2 seconds) will switch the smoker pump ON.

Moving the switch to <A> once more for a short blip (1 – 2 seconds) will switch the smoker pump OFF

Once the THROT: position exceeds 50 and the minimum airspeed of the aircraft exceeds 50Mph (80 Km/h) moving the switch to <C> for a short blip (1 – 2 seconds) will engage cruise control at the current speed of the aircraft
Moving the switch to <C> once more for a short blip (1 – 2 seconds) will disengage cruise control.

NOTE: Cruise control is also automatically disengaged when moving the throttle stick to less than 50. Function inactive with “SET MAX AIRSPEED” disabled.

MODE 7:

"<A>=SMOKE =OFF "

Description: Same as mode 4 but no autostart option via the switch channel. Requires a 2 position switch action. The position “” is the normal position i.e.. “OFF”. When the turbine is not running moving the switch to <A> has no effect. Once the Turbine RPM exceeds 80 000 and the EGT exceeds 450 deg C, the switch will behave as follows:

Moving the switch to <A> for a short blip (1 – 2 seconds) will switch the smoker pump ON.

Moving the switch to <A> once more for a short blip (1 – 2 seconds) will switch the smoker pump OFF

Moving the switch to <A> and holding it there will switch the smoker pump ON at the normal pump power. After 2 seconds the smoke pump power will be reduced slowly to zero and then increased again to the maximum value programmed. Releasing the switch at any point will set the normal pump value to that at the time the switch was released. This setting will remain and is saved in non-volatile memory until reset by the same action.

Should the Turbine RPM drop below 80 000 or the EGT drops below 450 deg C the smoker pump will be turned off, regardless of the switch position.

MODE 8:

"<A>=CRUISE =OFF "

Description: This mode allows you to engage cruise control via the switch channel. Requires a 2 position switch action. The position “” is the normal position i.e.. “OFF”. When the turbine is not running moving the switch to <A> has no effect. Once the THROT: position exceeds 50 and the minimum airspeed of the aircraft exceeds 50Mph (80 Km/h) the switch will behave as follows:

Moving the switch to <A> for a short blip (1 – 2 seconds) will engage cruise control at the current speed of the aircraft
Moving the switch to <A> once more for a short blip (1 – 2 seconds) will disengage cruise control.

NOTE: Cruise control is also automatically disengaged when moving the throttle stick to less than 50. Function inactive with “SET MAX AIRSPEED” disabled.

MODE 9:

"DISABLE SWITCH CHANNEL "

Select this option if you do not wish to utilize the auxiliary switch channel.

Important note: When selecting to disable the auxiliary switch channel, another method for starting the turbine remotely is activated automatically. See section “**THROTTLE STARTING**” for details of remote starting your turbine using only the throttle channel. Of course the turbine may be started by using the GSU at any time.

Once you have selected any of the modes 1 through 5, the menu will proceed to the switch setup dialog screen "SET SWITCH <A> ". Move the switch to the ON position i.e.. position <A>, and whilst holding it there press <E>.

The menu will then proceed to the switch setup dialog screen "SET SWITCH ". Move the switch to the OFF position i.e. position , and whilst holding it there press <E>.

If you have selected modes 2 - 5 requiring a 2 position switch, the menu will then return to the main menu tree.

If you have selected mode 1 or 6 requiring a 3 position switch, the menu will then proceed to the switch setup dialog screen "SET SWITCH <C> ". Move the switch to the other ON position i.e. position <C>, and whilst holding it there press <E>.

Your selection of the mode for the auxiliary channel switch is now complete.

ADJUST GLOWPLUG:

This option allows the user to set the TCU glowdriver for the Gloplug used in his turbine. We recommend the ROSSI #7 or #8 plug. (Refer to figure 6)

Remove the Gloplug and connect to the positive lead. Use long nose pliers to hold the body of the plug to the casing of the turbine. (negative supply)

When "SET GLOW VOLTS" is displayed press <1> followed by the “UP” key to increase brightness and “DOWN” key to lessen the brightness. The equivalent voltage will be displayed. The ideal brightness is the same as the brightness when lit by any normal NiCad Driver. Press <E> to save the setting to memory. Replace Gloplug.

Note: The TCU will adjust its output automatically to compensate for varying battery load conditions so as to ensure adequate glow heat when required.

FAST CHARGE BATT:

This option allows the user to fast charge the pump battery. This method of charging utilizes the Delta Peak principle and will automatically terminate the charge once fully

charged. In order to prevent false peaking with a drained battery the first 20 seconds of the fast charge cycle can only be terminated by pressing <C> if needed. The charge cycle can also be terminated thereafter by pressing <C>. The input voltage of the charge source, the charge current, pump battery voltage as well as the elapsed time for the charge cycle is displayed in real time. Once the charge has been terminated after the detection of the peak voltage drop, the GSU beeper will sound and the total charge time as well as the peak voltage is displayed. This allows the charge to proceed unattended while allowing the user to verify the charge period and peak voltage some time later. The charge termination dialog screen can then be cleared by pressing <C>.

SLOW CHARGE BATT:

This option is useful when the Pump Battery is completely empty and needs to be slowly trickle charged. Under these conditions the Pump Battery may not reliably fast charge.

The input voltage of the charge source, the charge current, pump battery voltage as well as elapsed time for the charge cycle is displayed in real time. After slow charging for a while the charge may be terminated by pressing <C> and fast charge selected. Also use this option for overnight charging of the pump battery.

SET MAX AIRSPEED:

This option together with the optional pitot tube sensor, allows the user to set the maximum airspeed for the airframe utilizing the BMT160KS. The airspeed can only be adjusted between 85 and the maximum speed described in the AMA regulations for aircraft with a higher thrust to weight ratio as described in the AMA regulation. When the dialog "SET MAX AIRSPEED" , is displayed the value may be adjusted in 10 mph increments by pressing the <UP> or <DOWN> keys. Pressing <LEFT> or <RIGHT> keys will adjust with increments of 1 mph. Pressing <E> will commit the new value to non-volatile memory.

Note: To disable this feature the airspeed should be set to below the minimum value. Consult your airframe manufacturer or alternatively an experienced airframe builder to determine the VNE of your particular airframe. HINT: After a flight press <3> to view the maximum airspeed recorded for that flight.

SETUP SMOKER:

This option, visible only with the selection of either auxiliary channel switch modes 4 or 5, allows the user to set the absolute maximum drive for the smoker pump. (BMT part #SP-01). This value may be adjusted in the range of 0 – 100. It represents the percentage of drive the TCU will pass through to the pump as a percentage of pump battery voltage. When selected the dialog "SET SMOKER PUMP" will appear. The current value will be displayed and may be adjusted in 10 % increments by pressing the <UP> or <DOWN> keys. Pressing <LEFT> or <RIGHT> keys will adjust with increments of 1 %. Pressing <E> will commit the new value to non-volatile memory. The normal default value used in flight will be 75% of the percentage selected. Refer to SWITCH MODE SETUP for a description of how to re-adjust the normal default value in flight.

NOTE: Should the TCU software detect a low battery voltage condition it will disable the smoker function for the rest of the run.

SET DATE/TIME :

This option allows the adjustment of the real time clock within the TCU. This clock is non-volatile and independently powered by an integrated battery backup supply good for more than 10 years. It provides the means by which datalog records for each start and flight may be time stamped to facilitate meaningful operational and service history. See literature supplied with the "BMT Flight DATA Center" software for a full description of the datalogging features within the BMT 160 KS TCU.

When selected the first dialog "SET YEAR" will appear, together with the current date and time in the following format:

"CCYY/MM/DD HH:mm", where
"CC" denotes the century,
"YY" the year,
"MM" the month,
"DD" the day of month,
"HH" the hour in 0 – 23 format and
"mm" the minute within the hour.

The century is not adjustable and pressing <UP> or <DOWN> will increment/decrement the year. Pressing <E> will update the clock and the next dialog "SET MONTH", will appear. Follow the same procedure for "SET MONTH", "SET DAY", "SET HOUR" and "SET MINUTES" dialogs until the date is current. The menu will then return to the main menu tree.

DO COOLDOWN

This option when selected will complete a full cooldown cycle if required. Normally any shutdown of the turbine is automatically followed by a cooldown cycle.

The coolcycle dialog will return to the main menu tree when completed or if aborted by pressing <C>. HINT: Press <1> to engage starter and <0> to disengage for a manual cooldown without invoking the menu.

CLEAR ERROR:

This option clears the TCU error reporting which may have occurred whilst running and/or in flight and is displayed on the LCD after shutdown. Because the error is kept in memory even when power is lost this error remains until cleared by the user.

LOAD DEFAULTS

Use this option only when directed to do so by a BMT service representative. The TCU will default to factory settings.

TEST FUEL PUMP

Using this option allows the user to test the fuel pump and associated plumbing/fuel tanks. The relevant solenoid fuel valves contained within the turbine will be set to return fuel to the main tank via the return line during the test. This is also the

case even when the electrical connections are temporarily disconnected. The turbine cannot be flooded with fuel when correctly wired and plumbed. Refer to figures 1 – 5 for a full description of the fuel system and diagrams.

When selected the dialog "<1>=PRIME<2>=OFF<3>=IDLE PV: 0000" will appear.

Pressing <1> will turn on the fuel pump as it would when an autostart sequence is initiated in order to prime the pump and injector system within the turbine.

Pressing <2> will turn the pump OFF.

Pressing <3> will set the pump to run at the idle setting. Any mechanical binding or pump wear may be detected by monitoring the flowrate consistency and repeatability of the pump speed when alternatively toggled between OFF and idle. The value displayed after "PV:" reflects the internal number used by the pump control algorithm and is only used as a diagnostic aid by BMT service personnel.

TEST INJECTOR

This function is essential for injector maintenance by the end user, should it ever be required. **Only** use this option when the injector has been removed for cleaning and placed within a suitable transparent plastic container. Refer to the section "**INJECTOR MAINTENANCE**" for more details.

When selected the dialog "<1>= ON <2>= OFF <3>= SHORT BLIP" will appear.

Pressing <1> will pump fuel at the appropriate rate and pressure to the injector during which time the spray pattern may be observed.

Pressing <2> will close the injector solenoid valve and stop the pump.

Pressing <3> will emit a fixed amount of fuel from the injector and may be used to diagnose fuel flow rate.

Pressing <5> with the retaining screw removed will eject the injector insert. Refer to "INJECTOR MAINTENANCE" section.

Pressing <C> will return the dialog to the main menu tree.

TEST STARTER

This function is useful for evaluating starter and/or battery supply performance. The starter draws a significant amount of current and observing RPM together with voltage is a good test of the starter system.

When selected the dialog "<1>=ON <2>=OFF RPM: 000 V:5.34" will appear. The voltage displayed is that of the pump battery.

Pressing <1> will turn the starter on, during which time the RPM attained may be observed together with the battery voltage.

Pressing <2> turns the starter off.

Pressing <C> will return the dialog to the main menu tree.

NOTE: When testing the starter with the GSU connected to a 12V source, the GSU will supply an additional 3 Amps of current to support the pump battery.

LUBE BEARINGS

This option allows the user to easily and safely apply lubrication to the bearing system should it become dry. For proper use of this feature refer to section "**BEARING MAINTENANCE AND CARE**"

SET MAX RPM:

This option may be very important for airframe applications where maximum thrust may cause the maximum flight speed of the airframe to be exceeded, in the event of the speed limiting feature not being employed.

This option must be used with care. Please consult your supplier of the airframe to advise you on the maximum thrust for your particular model.

When "ENTER MAX RPM" is selected "OLD MAX = xxx KRPM" will be displayed. A new value may be selected by using the <UP> and <DOWN> keys for 10 KRPM increments. Use the <LEFT> and <RIGHT> arrow keys to adjust in 1 KRPM increments. Press <E> to save the new setting to TCU memory.

IMPORTANT NOTE: It is not possible to set RPM higher than the certified thrust level requires, only less. The use of this feature however does not constitute compliance for any particular aircraft in terms of the AMA Thrust to Weight Regulation. Consult your dealer to effect re-certification of your turbine to the appropriate thrust level.

SET PITOT GAINS:

This option allows the pilot to set the very important parameters that will determine the good behavior of the cruise control and speed limiter function. Refer to the datasheet supplied with the optional speed sensor and Pitot tube kit.

SET LOGGING RATE:

This option allows the user to set the rate at which data is recorded to the internal memory. It may be set independently for the autostart procedure and normal running mode. Selecting a sample rate of 4 data records (32 bytes) per second during startup could be handy when diagnosing the autostart procedure. To utilize the maximum recordable flight time set both rates to 1 data record (8 bytes) per second. Each start attempt generates a record of the settings pertaining to that start. See "Flight Data Center" software help for more information. When selected the LCD will read as follows:

"<L><R> or <U><D>S: 4* R: 1 "

The asterisk '*' character denotes which setting is being adjusted and can be alternated by pressing <L> or <R> arrow keys. The number following "S:" sets the rate for STARTING mode and the number following "R:" sets the rate for RUNNING mode. Press <U> or <D> to adjust the rates.

FAILSAFE SETUP

This option allows the user to set the failsafe behavior of the BMT160KS in the event of failsafe being engaged by the Receiver due to loss of signal. There are two settings that relate to this function. Firstly the time delay to failsafe shutdown must be set. Setting this value to zero will disable this function. The TCU will then simply follow the Throttle channel input as determined by the user in the TX failsafe setup. To set a timeout value use the <U> and <D> arrow keys to adjust the value in 100ms intervals to a maximum of 10 000ms or 10 seconds. You may also enter any other value by typing

on the keypad. Press <E> to save the value. Next the input channel width dialog will be displayed. The pulsewidth in microseconds will be displayed for your convenience. The value should be at least 200 microseconds outside that set in <SET THROT MIN> dialog in <SET THROTTLE> Temporarily expand your throttle channel endpoint to achieve this while at the same time setting this value as your "FAILSAFE" position on the TX. Should the value entered fall outside the required limits an error message will appear. Please remember to reset the normal channel endpoint as before. Once setup correctly the system will behave as follows. With the RX in failsafe the Turbine will immediately spool down to idle where it will remain. Should the failsafe condition not clear within the time limit set the turbine will be shut down. All functions in the TCU will cease so as to reduce any EMI to the RX that may exist. In the event of the failsafe condition clearing before the set timeout, normal operation of the throttle function will resume. After the subsequent normal shutdown an error message will be displayed along with the count of failsafe "hits" encountered during the flight.

THROTTLE STARTING

As explained in section "SET SWITCH MODE" selecting modes 7, 8, or 9 enables remote starting via the throttle stick. When the TCU is in the DORMANT state, i.e. not starting, running or cooling down, the status LED will be STEADY GREEN.

To start the turbine move the throttle to full throttle for about a second. Then move the throttle to closed and then up to about $\frac{3}{4}$ position. The LED will alternate RED/GREEN to indicate the start sequence has been detected. Now move back to idle again and back to $\frac{3}{4}$ position and once again back to idle and then back to $\frac{3}{4}$ for the third time and hold it there. After a short delay the turbine will commence its starting sequence. Should the sequence not be executed correctly the LED will revert to STEADY GREEN. You may retry the sequence at this point.

Installation of TCU in the airframe

Careful consideration and planning has to be done when installing the turbine support system in the aircraft. Ideally all wiring and cables should be as short as possible and well insulated from turbine heat. It is also good practice to keep the TCU and associated wiring well clear of the RX and servo wiring. The minimum safe distance between RX and TCU is 5 cm (2 inches). Where possible the RX battery and TCU battery should also be kept apart but where this may be inconvenient to obtain the correct center of gravity please position them end to end so as to reduce the possibility of RF "cross coupling". Wrapping aluminum foil around both batteries is a good idea. The RX antenna position is also important. It should be clear of any wiring and never be allowed to run close to the metal of the exhaust ducting. Mount the thermocouple sensor as per figure 7. Should you wish to shorten the thermocouple cable disassemble the plug, cut the wire to length and re-attach the wires.

Important: Keep a note of the wire polarity. Bad connections here will cause the TCU not to start or to unexpectedly shutdown the engine.

Installing the turbine in the airframe

In order to have a safe model to operate it is very important to install the turbine with due care. If you have no experience of turbine models it is highly recommended that you use an airframe specifically designed for turbines or obtain a suitable conversion kit for your model. ALWAYS follow the recommendations of the airframe designer. If you have any doubt about your ability in this regard seek professional help from your dealer

or airframe manufacturer. Airframes designed for Ducted Fan power is not always suitable for direct conversion due to the following differences:

- a) Turbine installed weight is higher
- b) Fuel load/take-off weight is higher
- c) Undercarriage loads are higher due to increased weight and landing speed.

For experienced turbine operators and airframe designers we have included some guidelines as to inlet and exhaust ducting. Carefully study figure 8.

Air inlet ducting:

Air inlet ducting should be smooth and free of obstructions. Excessive turbulence will cause degradation of performance and higher turbine operating temperature. Inlet ducting around the front of the turbine must be of a suitable material like high temperature epoxy capable of withstanding temperatures of at least 100 deg C.

Jet exhaust ducting:

Study figure 8 for details of dimensions. Suitable material for inner duct is 0.1 - 0.3 mm stainless steel or ideally titanium sheet. The outer ducting may be as thin as 0.1 mm to save weight. When using material thinner than 0.3 mm for the inner duct it is important to reinforce the center of the tube to prevent it from collapsing due to venturi effect. Take note of the stagger of the inner and outer ducts to enhance the introduction of cooling air.

Fuel System and installation

Carefully study the Fuel System diagrams in figures 2 - 5. It is important to keep all tubing as short as possible while at the same time ensuring that no possibility exists of any of the tubing kinking. Where tubing must be routed through tight radii use elbow joiners Try and locate the fuel cells as close as possible to the center of gravity. It is imperative that the fuel system be clean and free from leaks to ensure safe and reliable operation. The fuel line from pump to engine is under considerable pressure and all joining fittings should be checked regularly. An important aspect of safe turbine operation is the fuel shut-off solenoid valves integrated into the turbine. These valves serves to prevent flooding of the engine which may cause potentially dangerous wet starts. The valves are controlled by the TCU.

IMPORTANT NOTE: The Festo "Quick" Push -on connectors will after a few connects and disconnects cause an indent to form on the fuel tubing. This may cause the tubing to not seal properly. For this reason these joints should be checked before connecting and where necessary the indent should be cut off or the tubing replaced. When removing the refueling and air vent tubing after re-fueling, be careful not to spill fuel onto the airframe. Use an absorbent rag or paper towel to wipe any fuel residues from the airframe. Plastic parts should immediately be cleaned with a cleaning detergent capable of removing oil residues as the turbine oil/Jet A mix degrades some plastics in a very short space of time.

Starting the BMT160-KS

1. Pre-flight check:

- a) Check for fuel leaks.
- b) Ensure that your fire extinguisher is close at hand
- c) Clear the startup area of any obstructions and spectators.
- d) Ensure your helper is holding the aircraft stationary.
- e) Do a complete range check of your R/C system with the TCU powered. The range achieved should be in accordance with the manufacturer of your equipment.

2. Connect the GSU to TCU.

3. Power up the R/C system and so the TCU. Set throttle trim to the mid position and throttle stick to minimum.

4. Check the GSU for display of throttle value between 001 and 004.

NOTE: It is also possible to start the BMT160KS without the RC system being powered or even plugged in. To throttle the engine manually after idle calibration use the numeric keys to set throttle position. In this case the keys will behave as follows:

<0> = Idle.

<1> to <9> = 10% to 90% throttle.

<UP> and <DOWN> = +1% and -1% of current throttle setting respectively.

<LEFT> = idle.

<RIGHT> = 100% throttle

Once the RC system is powered it will resume control of the throttle function only once the throttle stick position is at idle. (SAFETY FEATURE: prevents unexpected spool-up) Should RC system be powered down again, the engine will be shut down immediately.

5. Press "START".

NOTE: With the GSU plugged into the TCU and connected to a 12V source, the GSU will supply an additional 3 Amps of current to support the pump battery during startup. This is useful under cold conditions or the first starts of the day with dry bearings.

6. While the TCU is executing the automatic startup procedure it is important to listen and observe for any abnormal conditions. Should any problem occur the TCU will almost always shut down the engine but the user has the discretion to abort the start by pressing the "ABORT START" button on the GSU. The TCU will calibrate the idle position each time upon startup by slowly reducing RPM to the idle setting. Once this has been completed the user has control of the engine via the throttle stick or keypad.

7. When the engine is running check the high RPM setting of the engine to verify the engine is running reliably before commencing with takeoff. The first spoolup attempt will be slower than normal as the TCU calibrates the maximum RPM setting. To shutdown the engine move throttle and trim to the minimum position.

Shut-down sequence

1. Connect GSU to Aircraft system (optional)
2. Press "SHUTDOWN" OR Close Throttle and pull down trim lever.
3. The engine will be shut down by the TCU and commence with a cooldown sequence. Once an EGT of 100 deg C has been reached the sequence is complete.

NOTE: It is preferable to shutdown the turbine after spooling up to about 60 KRPM, waiting a few seconds and then shut down. This shortens the cooldown cycle somewhat and reduces starter motor loading. Also, with the GSU connected to a 12V source, the GSU will supply an additional 3 Amps of current to support the pump battery during cooldown when the pump battery may already be low after a long flight.

Errors reported by the GSU

Two categories of errors may be encountered during turbine operation.

- 1) Startup Errors. These occur only during startup sequences and may be cleared by pressing <C>
- 2) Runtime Errors. These occur during the running sequence and because they are non-volatile can only be cleared by using the Menu option "CLEAR ERROR" on the GSU. Some errors can also occur during or before startup.

NOTE: Errors cannot be cleared by powering the system down and then up again. The errors remain until cleared by the operator using the GSU.

Startup Error listing:

```
"EGT PROBE FAIL! CHECK PROBE.... " ,
"GLOWPLUG FAILED!CHECK PLUG..... " ,
"PUMP OVERSPEED! CHECK PUMP.... " ,
"PUMP UNDERSPEED!CHECK PUMP..... " ,
"STARTER FAILURE!CHECK STARTER.. " ,
"START RPM FAIL! CHARGE BATTERY? " ,
"START BATT LOW! CHARGE BATTERY " ,
"TURBINE TOO HOT!RETRY START.... " ,
"RPM RUNDOWN ERR!LUBE BEARINGS? " ,
"NO IGNITION! CHECK INJECTOR " ,
"POST IGNITION TIMEOUT ERROR! " ,
"POST IGNITION RPM DROP ERROR! " ,
"POST IGNITION EGT DROP ERROR! " ,
"POST IGNITION EGT MAX ERROR! " ,
"PWM INITIALISE TIMEOUT ERROR! " ,
"PWM INITIALISE RPM DROP ERROR! " ,
"PWM INITIALISE EGT DROP ERROR! " ,
"PWM INITIALISE EGT MAX ERROR! " ,
"IDLE SPOOLUP TIMEOUT ERROR! " ,
"IDLE SPOOLUP RPM DROP ERROR! " ,
"IDLE SPOOLUP EGT DROP ERROR! " ,
"IDLE SPOOLUP EGT MAX ERROR! " ,
"IDLE CALIBRATE TIMEOUT ERROR! " ,
"IDLE CALIBRATE RPM DROP ERROR! " ,
"IDLE CALIBRATE EGT DROP ERROR! " ,
```

"IDLE CALIBRATE EGT MAX ERROR! ".

Runtime error listing:

"RUN EGT HIGH! CLEAR IN MENU...",
"EGT OVER MAXED! CLEAR IN MENU...",
"RUN EGT LOW! PROBE?/FLAMEOUT?",
"FLAMEOUT ERROR! FUEL STARVATION?",
"RUN RPM HIGH! CLEAR IN MENU...",
"RPM OVER MAXED! CLEAR IN MENU...",
"RUN RPM LOW! FUEL STARVATION?",
"MINIMUM RPM ERR FUEL STARVATION?",
"PUMP BATT LOW! CHARGE BATTERY! ",
"RX BATTERY LOW! CHARGE RX PACK! ",
"NO RX SIGNAL! DO RANGE CHECK! ",
"EGT PROBE ERR! CHECK EGT PROBE!",
"RUN PUMP FAIL! CHECK PUMP! ",
"WATCHDOG TIMER! CLEAR IN MENU..."
"FAILSAFE ERROR: HITS = 1 ".

Startup Errors explained and remedies:

"EGT PROBE FAIL! CHECK PROBE.... "

Cause: The Thermocouple is not plugged in or has bad(open circuit) connection.

Effect: The TCU is unable to sense EGT.

Remedy: Check connections internally at plug by opening cover. Repair/replace if necessary.

"GLOWPLUG FAILED!CHECK PLUG..... ",

Cause: The Gloplug is not connected or has bad(open circuit) connection.

Effect: The TCU is unable to ignite Fuel.

Remedy: Check connections externally at plug. Replace if necessary.

"PUMP OVERSPEED! CHECK PUMP.... ",

Cause: The Pump is not connected, has a bad connection or the MOSFETT transistor has shorted.

Effect: The TCU cannot reduce the pump speed.

Remedy: Check connections at plug and pump. Replace if necessary. If problem persists, return for repair.

"PUMP UNDERSPEED!CHECK PUMP..... ",

Cause: The Pump is not connected, has a bad connection or the MOSFETT transistor has failed open circuit.

Effect: The TCU cannot increase the pump speed.

Remedy: Check connections at plug and pump. Replace if necessary. If problem persists, return for repair.

"STARTER FAILURE!CHECK STARTER.. ",

Cause: The Turbine Power is not connected, has a bad connection or the MOSFETT transistor has failed open circuit.

Effect: The TCU cannot detect RPM with starter on.

Remedy: Check connections at plug and battery. Replace if necessary. If problem persists, return for repair.

"START RPM FAIL! CHARGE BATTERY? ",

Cause: The Turbine Power has a bad connection , Battery voltage is low or the starter is slipping on the spinner nut.

Effect: The TCU cannot detect sufficient RPM with starter on.

Remedy: Check connections at plug and battery and charge battery to full capacity. Clean any oil from the spinner nut and starter cup "O" ring. Replace "O" ring if necessary.

"START BATT LOW! CHARGE BATTERY " ,

Cause: Battery voltage is low under starter load.

Effect: The TCU detected a too low voltage and RPM.

Remedy: Check connections at plug and battery and charge battery to full capacity.

"TURBINE TOO HOT!RETRY START.... " ,

Cause: The EGT after starter test rundown was excessive

Effect: The TCU cannot reliably detect ignition.

Remedy: This error pre-empts a cooldown cycle. Retry the start.

"RPM RUNDOWN ERR!LUBE BEARINGS? " ,

Cause: The TCU detected a too rapid rundown time after initial starter test sequence, possibly due to dry or binding bearings and/or rotor.

Effect: The TCU cannot complete the start sequence.

Remedy: Refer to section "BEARING MAINTENANCE"

"NO IGNITION! CHECK INJECTOR " ,

Cause: The start fuel did not ignite in allowed time.

Effect: The TCU cannot complete the start sequence.

Remedy: Fuel injector pressure to low, or blocked. Refer to section "**INJECTOR MAINTENANCE**"

"POST IGNITION TIMEOUT ERROR! " ,

Cause: The turbine did not reach required RPM and EGT in allowed time during this phase.

Effect: The TCU cannot complete the start sequence.

Remedy: Fuel injector pressure to low . Refer to section "**ADJUSTING INJECTOR FLOWRATE**"

"POST IGNITION RPM DROP ERROR! " ,

Cause: The TCU detected an unexpected drop in RPM during this phase.

Effect: The TCU cannot complete the start sequence.

Remedy: Fuel injector pressure to low or rotor bind. Refer to section "**ADJUSTING INJECTOR FLOWRATE**"

"POST IGNITION EGT DROP ERROR! " ,

Cause: The TCU detected an unexpected drop in EGT during this phase.

Effect: The TCU cannot complete the start sequence.

Remedy: Fuel injector pressure to low , flamed out. Refer to section "**ADJUSTING INJECTOR FLOWRATE**"

"POST IGNITION EGT MAX ERROR! " ,

Cause: The TCU detected an excessively high EGT during this phase.

Effect: The TCU cannot complete the start sequence.

Remedy: Fuel injector pressure to high or wet start. Clear engine of any excess fuel. Refer to section "**ADJUSTING INJECTOR FLOWRATE**"

"IDLE SPOOLUP TIMEOUT ERROR! " ,

Cause: The turbine did not reach required RPM and EGT in allowed time during this phase.

Effect: The TCU cannot complete the start sequence.

Remedy: Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE SPOOLUP RPM DROP ERROR! " ,

Cause: The TCU detected an unexpected drop in RPM during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE SPOOLUP EGT DROP ERROR! " ,

Cause: The TCU detected an unexpected drop in EGT during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Clear engine of any excess fuel. Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE SPOOLUP EGT MAX ERROR! " ,

Cause: The TCU detected an excessively high EGT during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE CALIBRATE TIMEOUT ERROR! " ,

Cause: The turbine did not reach required RPM and EGT in allowed time during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE CALIBRATE RPM DROP ERROR! " ,

Cause: The TCU detected an unexpected drop in RPM during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE CALIBRATE EGT DROP ERROR! " ,

Cause: The TCU detected an unexpected drop in EGT during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

" IDLE CALIBRATE EGT MAX ERROR! " ,

Cause: The TCU detected an excessively high EGT during this phase.
Effect: The TCU cannot complete the start sequence.
Remedy: Clear engine of any excess fuel. Retry the start, if problem persist, contact your BMT field representative. Some factory settings may need adjustment.

Runtime Errors explained and remedies:

"RUN EGT HIGH! CLEAR IN MENU...",

Cause: The TCU detected an excessively high EGT whilst running.

Effect: The TCU will reduce power to maximum 75%.

Remedy: If problem persist, contact your BMT field representative. Some factory settings may need adjustment.

"EGT OVER MAXED! CLEAR IN MENU...",

Cause: The TCU detected an excessively high EGT whilst running and could not reduce EGT in required time.

Effect: The TCU will shutdown the engine.

Remedy: If problem persist, contact your BMT field representative. Some factory settings may need adjustment.

"RUN EGT LOW! PROBE?/FLAMEOUT?",

Cause: The TCU detected an excessively low EGT whilst running. Probe may be dislocated.

Effect: The TCU will reduce power to maximum 75%.

Remedy: Check Probe position in exhaust nozzle. If problem persist, contact your BMT field representative. Some factory settings may need adjustment.

"FLAMEOUT ERROR! FUEL STARVATION?",

Cause: The TCU detected excessively low EGT and RPM whilst running.

Effect: The TCU will stop the pump.

Remedy: You ran out of fuel or if not, check fuel system and Fuel tanks for air ingestion/bubbles

"RUN RPM HIGH! CLEAR IN MENU...",

Cause: The TCU detected an excessively high RPM whilst running.

Effect: The TCU will reduce power to maximum 75%.

Remedy: If problem persist, contact your BMT field representative. Some factory settings may need adjustment.

"RPM OVER MAXED! CLEAR IN MENU...",

Cause: The TCU detected an excessively high RPM whilst running and could not reduce RPM in required time.

Effect: The TCU will shutdown the engine.

Remedy: If problem persist, contact your BMT field representative. Some factory settings may need adjustment.

"RUN RPM LOW! FUEL STARVATION?",

Cause: The TCU detected an excessively low RPM whilst running.

Effect: The TCU will reduce power to maximum 75%.

Remedy: You ran out of fuel or if not, check fuel system and Fuel tanks for air ingestion/bubbles. If problem persist, contact your BMT field representative. Some factory settings may need adjustment.

"MINIMUM RPM ERR FUEL STARVATION?" ,

Cause: The TCU detected an excessively low RPM whilst running.

Effect: The TCU will shut down the engine.

Remedy: You ran out of fuel or if not, check fuel system and Fuel tanks for air ingestion/bubbles. If problem persists, contact your BMT field representative. Some factory settings may need adjustment.

"PUMP BATT LOW! CHARGE BATTERY! " ,

Cause: The TCU detected an excessively low Pump Battery Voltage whilst running.

Effect: The TCU will reduce power to maximum 75%.

Remedy: Fully charge Battery. If necessary replace NiCad.

"RX BATTERY LOW! CHARGE RX PACK! " ,

Cause: The TCU detected an excessively low RX Battery Voltage whilst running.

Effect: The TCU will reduce power to maximum 75%.

Remedy: Fully charge RX Battery. If necessary replace NiCad.

"NO RX SIGNAL! DO RANGE CHECK! " ,

Cause: The TCU detected a loss of signal from the RX.

Effect: The TCU will shut down the engine

Remedy: Do range check if still possible.....

"EGT PROBE ERR! CHECK EGT PROBE!" ,

Cause: The TCU detected an open circuit condition of the EGT probe.

Effect: The TCU will shut down the engine

Remedy: Check Probe and connections, replace if failed.

"RUN PUMP FAIL! CHECK PUMP! " ,

Cause: The TCU could not maintain correct pump speed.

Effect: The TCU will shut down the engine

Remedy: Check Pump and connections, replace if failed.

"WATCHDOG TIMER! CLEAR IN MENU..." ,

Cause: The TCU software encountered an internal error.

Effect: The TCU will reset, shutting down the engine.

Remedy: Report to factory for software reload.

"FAILSAFE ERROR! HITS = 1 " ,

Cause: The RX went to failsafe condition.

Effect: The TCU will reduce power to idle, eventually shutting down the engine.

Remedy: Thoroughly check RC system and installation.

INJECTOR MAINTENANCE

The BMT KS series turbine engines are unique in their ability to start on a single fuel, i.e. Kerosene. The key component is the Start Fuel Atomizer or Injector. This

component utilizes very small orifices and will be prone to blockage if the fuel system is not kept clean.

The following is essential:

- 1) Use only Clean well filtered fuel, free from any moisture buildup which may cause algae to form in fuel tanks and plumbing.
- 2) Wherever possible use JETA or JETA-1 fuel from a sealed and certified container obtained from an aviation depot.
- 3) Use an automotive type fuel filter on you flightbox refueling system, capable of removing particles 50 micron or less.
- 4) When changing, removing or replacing any component of the fuel system, follow the fuel flush procedure as described below.

Testing the injector:

Before taking the injector apart it is advisable to test the injector outside of the turbine.

- 1) Remove the fuel line from injector Festo fitting by first pushing back the blue release ring and then pulling on the tubing.
- 2) Unscrew the injector from the turbine by turning anti-clockwise. You may have to move the Gloplug lead out of the way to do this.
- 3) Put the fuel line into a small jar, and from the "TEST INJECTOR" menu option select <1> to flush the line by pumping into the jar. If this proves difficult some length of fuel tubing with neoprene rubber hose as a joiner may be used to direct the fuel into a jar outside of the airframe. Press <2> to stop the fuel flow. This procedure aids in removing any dirt from the system.
- 4) Re-connect the injector to the fuel line and from the "TEST INJECTOR" menu option, select <3> to "BLIP" the injector. If the injector is clear, a small amount of fuel will be sprayed from the orifice with an approximate spray angle of 60 – 90 degrees as a fine mist. Replace injector into turbine. If the injector fails to release any fuel or a single jet of fuel is emitted, refer to next section.

Cleaning the Injector:

- 1) Ensure you have a clean working area for this task. Take care that should some small parts be dropped, they can easily be recovered.
- 2) This is a good time to check the condition of the bottom and top "O" rings. Replace if any damage is apparent. These "O" rings are less critical to the operation of the injector.

- 3) Using the small hex key provided, carefully loosen the M2 capscrew from the bottom of the Injector body, taking care not to lose the oval retaining washer.
- 4) Using the "TEST INJECTOR" menu option, select <5> to "EJECT" the injector insert and swirl disk into a small jar.
- 5) Carefully inspect the internal surfaces of the injector body and external surfaces of the injector insert and swirl disk for any dirt or deposits. You may want to keep a magnifying glass around for this task.
- 6) Inspect the injector insert "O"ring for damage. Any damage or loose rubber shed from the surface warrants the replacement of the "O" ring. Be careful not to use a sharp object to remove the "O" ring. It may damage the precision fit of the parts.
- 7) Flush the internals of the injector body using the procedure as in above section "Testing the Injector".
- 8) Put the injector insert and swirl disk into a clean Jar with some Fuel or Clean Acetone and shake it a bit to remove any deposits.
- 9) If you have compressed air available, blast some air through the injector orifice for good measure. Take care not to blast the injector insert and swirl disk into a no find zone....
- 10) Replace the swirl disk face down followed by the injector insert into the injector body, ensuring it is all the way home, using gentle but firm pressure.
- 11) Replace the oval washer making sure that only the tip of its end applies pressure in the center of the insert. A slight kink in the washer will do the trick .
- 12) Test the injector as before. If all is well replace into turbine by carefully turning the injector clockwise until GENTLE resistance is felt, indicating the bottom "O" ring is being slightly compressed.

NOTE: BMT can supply complete injector assemblies for the purpose of keeping a spare injector for quick turnaround replacement in the field. Only available to BMT owners.

ADJUSTING INJECTOR FLOWRATE

The KS autostart software is very sophisticated and largely automatic. Under some conditions it may be necessary to adjust the initial injector pump pressure to ensure a smooth startup. During startup some errors may occur with specific symptoms. From the error listing you may notice that the start sequence is divided into distinct phases. Each of these "phases" have a set of error reports associated with it, i.e.

- a) Timeout errors (Generally injector pressure to low or cold day)
- b) RPM drop errors (Generally injector pressure to low or cold day)
- c) EGT drop errors (Generally injector pressure to low or cold day)

d) MAX EGT errors (Start battery low, dry bearings or injector pressure to high)

In some phases however, timeout error is also possible under high fuel pressure with resultant high EGT conditions i.e. flamey hot starts.

Adjusting the pump fuel pressure:

From the menu select “TEST INJECTOR “. Remove the fuel line from the injector and direct into a small jar. Select option <1> and the fuel pump will deliver a given flowrate into the jar. By using the <UP> and <DOWN> keys, the fuel pump voltage may be adjusted up or down in increments of 100. This is generally too rough an adjustment, so instead you may use the <LEFT> and <RIGHT> arrow keys to adjust in steps of 10. Press <E> to save the value selected <C> will restore the original value Pressing <2> will stop the pump. Replace the fuel line.

Bearing Maintenance and Care

The BMT KS series engines has a high precision bearing system and little if any maintenance is required by the user. It may on occasion be necessary to lubricate the bearings manually should they become dry. This may be done by selecting the <LUBE BEARINGS> option from the menu. The following procedure is important to prevent a wet start following this procedure.

- 1) Hold the engine in a vertical position with the tailpipe towards the ground. Use a rag or paper towel to absorb any fuel that will drip from the tailpipe.
- 2) Press <1> to initiate lube sequence. The TCU will rotate the rotor and once it reached the a point where RPM does not increase any further will inject a fixed amount of fuel into the engine for a short period.
- 3) Observe the RPM reading on the display for an increase in RPM due to lubrication working its way through the system.
- 4) The starter will continue to spin for a few seconds to aid in the expelation of any excess fuel within the engine.
- 5) The procedure is timed and terminates automatically. The run down time will be displayed for reference. Press <C> to exit the menu.

IMPORTANT NOTE: The internal construction of the KS series engines allows all excess fuel to be removed from the housing using this method. Special drain channels bypassing the outer NGV casting drains fuel directly into the tailpipe. DO NOT attempt to drain fuel from the front of the engine as required for other engine designs. The drained fuel may end up in the starter motor instead or worse, within the front of your airframe.

PREVENTING WET STARTS

Should the turbine accumulate excess fuel for any reason, it must be cleared before starting the turbine otherwise a very hot start may result. While the TCU takes good care of the turbine and won't allow excessive temperature during the startup procedure,

any excess fuel expelled from the housing may cause excessive tailpipe temperatures undetected by the TCU. Select <TEST STARTER> from the menu.

- 1) Hold the engine in a vertical position with the tailpipe towards the ground. Use a rag or paper towel to absorb any fuel that will drip from the tailpipe.
- 2) Press <1> to engage the starter. The starter will generate a positive air pressure and a fair amount of airflow through the turbine forcing any fuel out the rear of the engine.
- 3) The procedure is done when no fuel is seen to be expelled from the tailcone. Press <C> to exit the menu.

IMPORTANT NOTE: The internal construction of the KS series engines allows all excess fuel to be removed from the housing using this method. Special drain channels bypassing the outer NGV casting drains fuel directly into the tailpipe. DO NOT attempt to drain fuel from the front of the engine as required for other engine designs. The drained fuel may end up in the starter motor instead or worse, within the front of your airframe.

The BMT160-KS in the long term

It is important to keep your turbine in good health. Regular inspection of the engine and keeping a log of all engine runs and possible problems encountered will help your dealer when service is required.

The following routine inspections are mandatory:

1. Check bearings for binding, abnormal noise, tight spots and roughness. Be aware however that dry bearings will often feel or sound rough. If in any doubt send your turbine in for service. Any drag caused by binding rotor wheels must be repaired by your dealer.
2. Check for any excessive discoloration of the engine casing forward of the turbine position. This may indicate overheating due to inadequate airflow.
3. Check all valves, tubing and joiners. Should any leaks be apparent the component must be replaced.
4. Check the engine mountings for structural integrity.
5. Change the Fuel Filter regularly.

GSU CHARGING

The GSU is equipped with its own independent software and hardware to charge any type of NiCad or Hydride type battery packs. When the GSU is powered from a 12V source and the TCU is disconnected, the Display will read "TCU offline... Input V: 12.0" Press <MENU> to invoke the charge menu. Scrolling up and down will reveal different charge rates for slow and fast charging. When using the "Charge at set rate option" the actual charge current may be adjusted by using the <UP> and <DOWN> arrow keys.

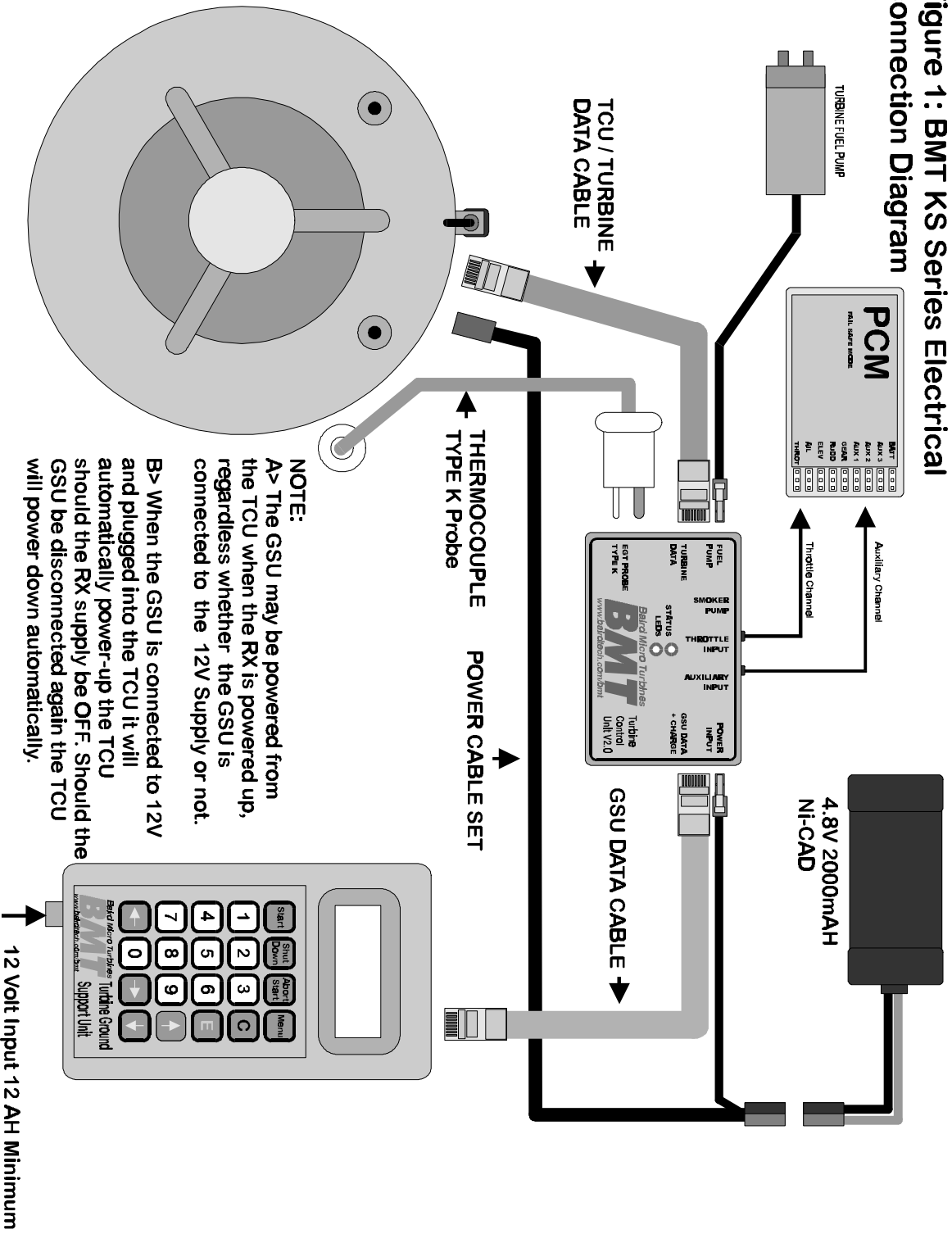
A special adapter is provided to enable RX packs to be charged. See figure 9 for details. GSU charging is also the only way to charge the pump battery when completely discharged and unable to power up the TCU.

NOTE: When charging any battery it is important to follow the charging rate specified for that specific type of battery.

Warranty information

Baird Micro Turbines (BMT) will repair any defect during the first 6 months of operation that may result due to defective materials or manufacturing. This will be done by BMT or where applicable, our representative in your region. BMT accepts no liability of any kind in terms of injury or damage to property due to the negligent or incompetent handling of the turbine engine. The user of the turbine must agree to the terms and conditions of the warranty by signing it and returning it to BMT or an official representative of BMT before operating the turbine.

Figure 1: BMT KS Series Electrical connection Diagram



NOTE:
 A> The GSU may be powered from the TCU when the RX is powered up, regardless whether the GSU is connected to the 12V Supply or not.
 B> When the GSU is connected to 12V and plugged into the TCU it will automatically power-up the TCU should the RX supply be OFF. Should the GSU be disconnected again the TCU will power down automatically.

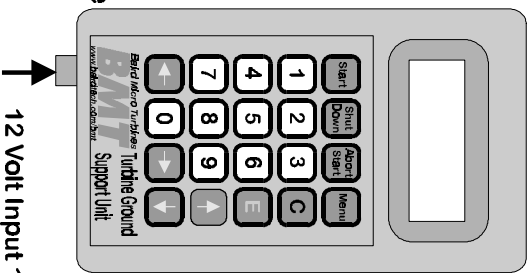


Figure 2: Fuel System Diagram with Spill-proof refueling
(Arrows indicate flow during REFUELING)

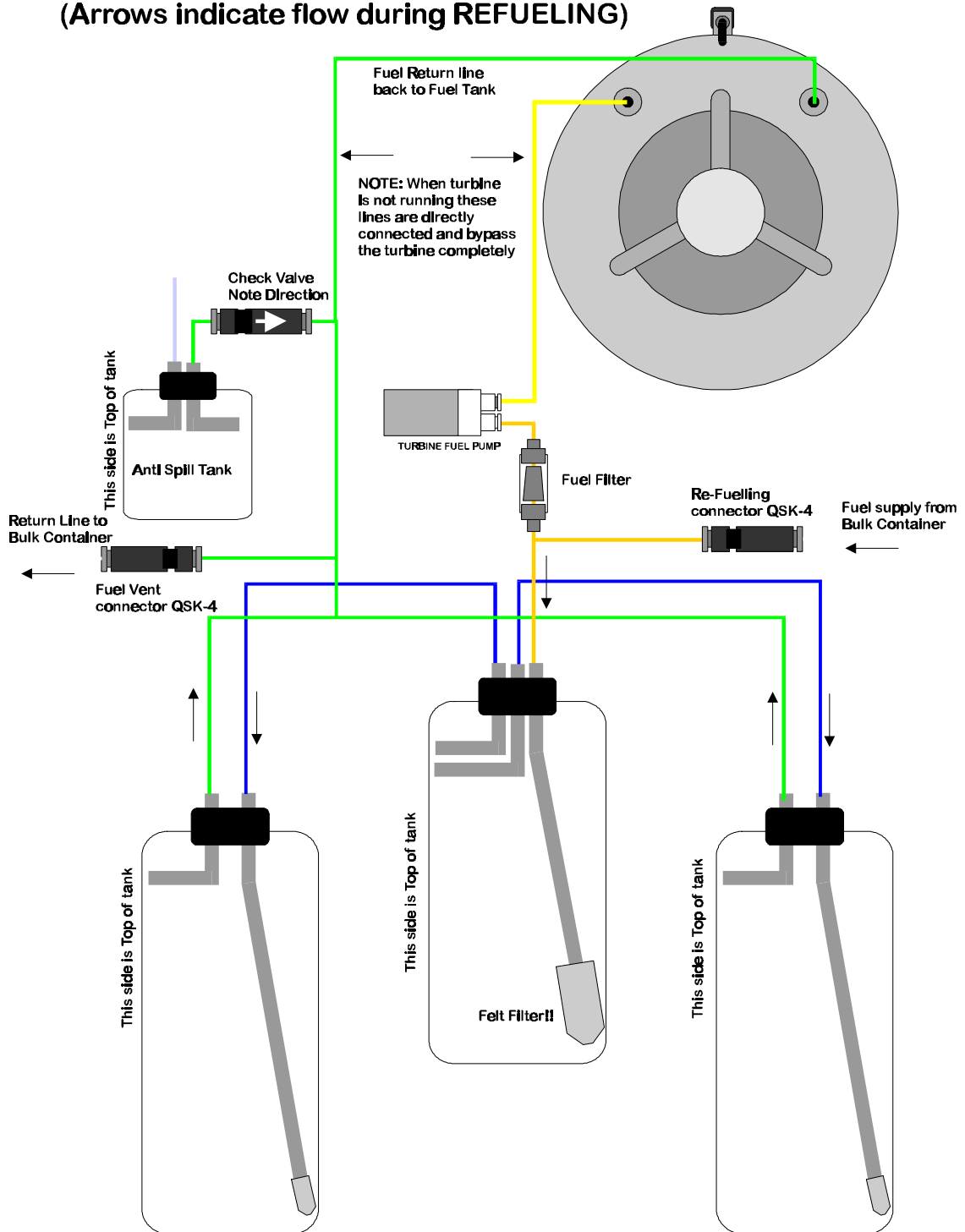
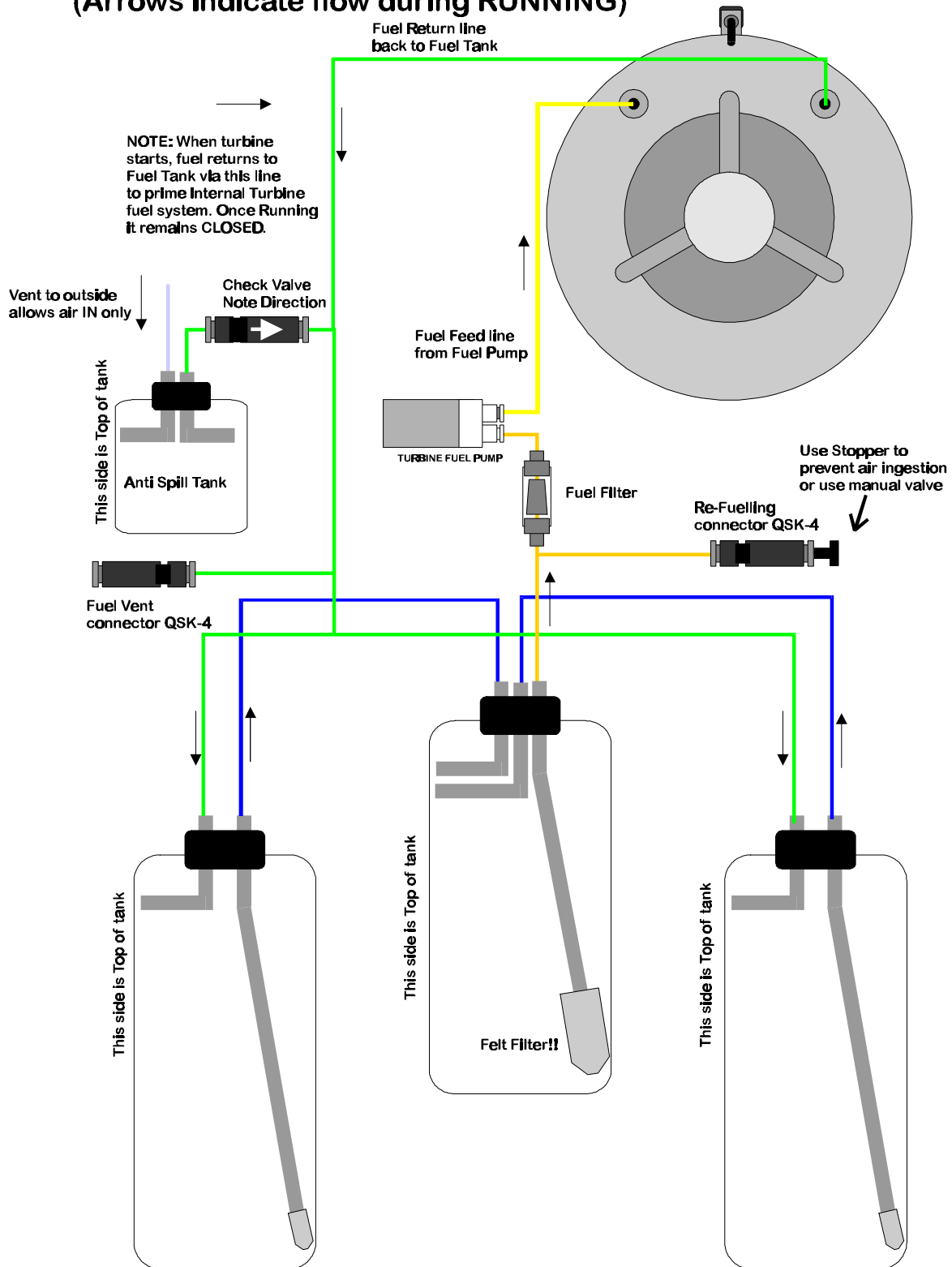
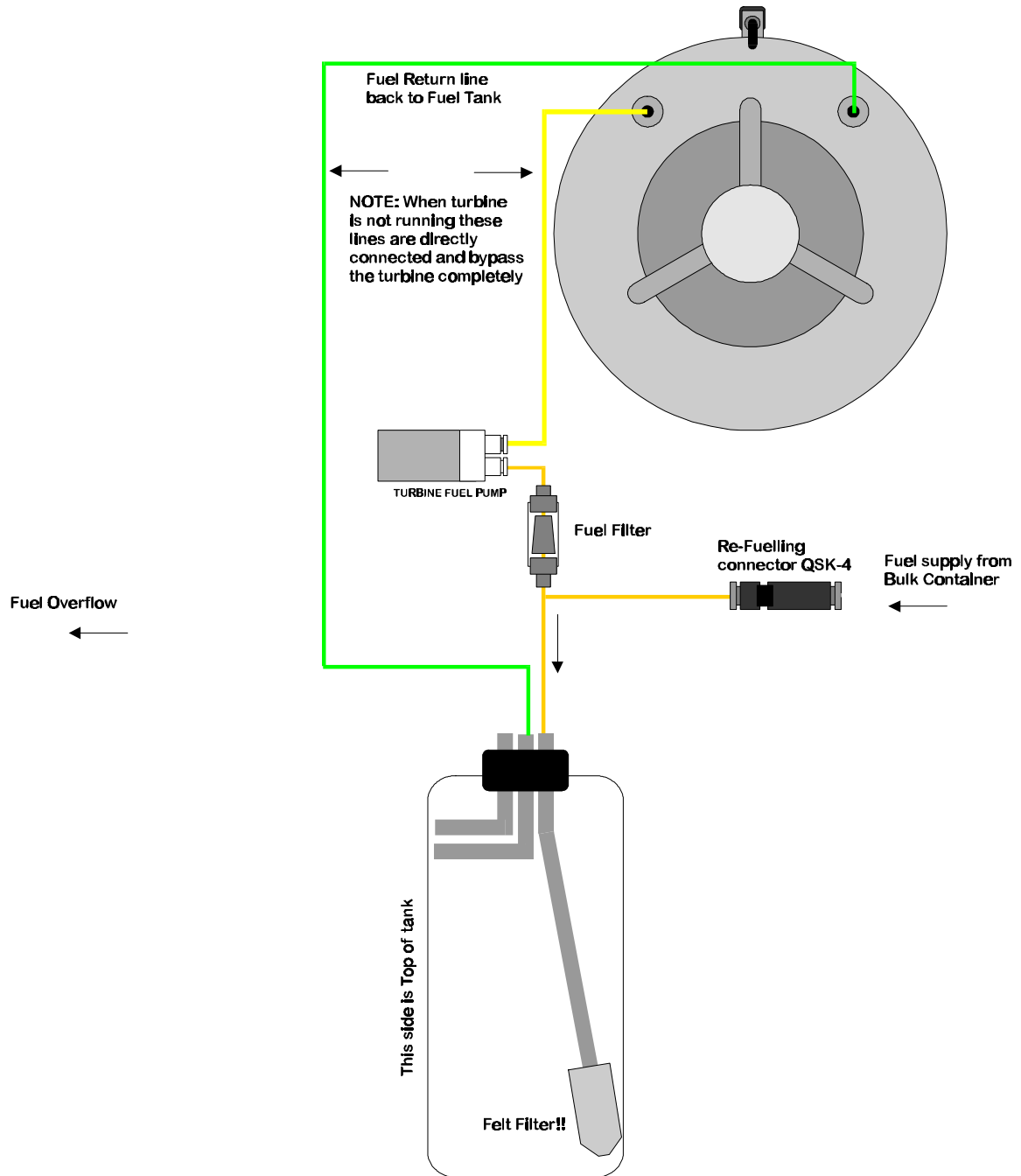


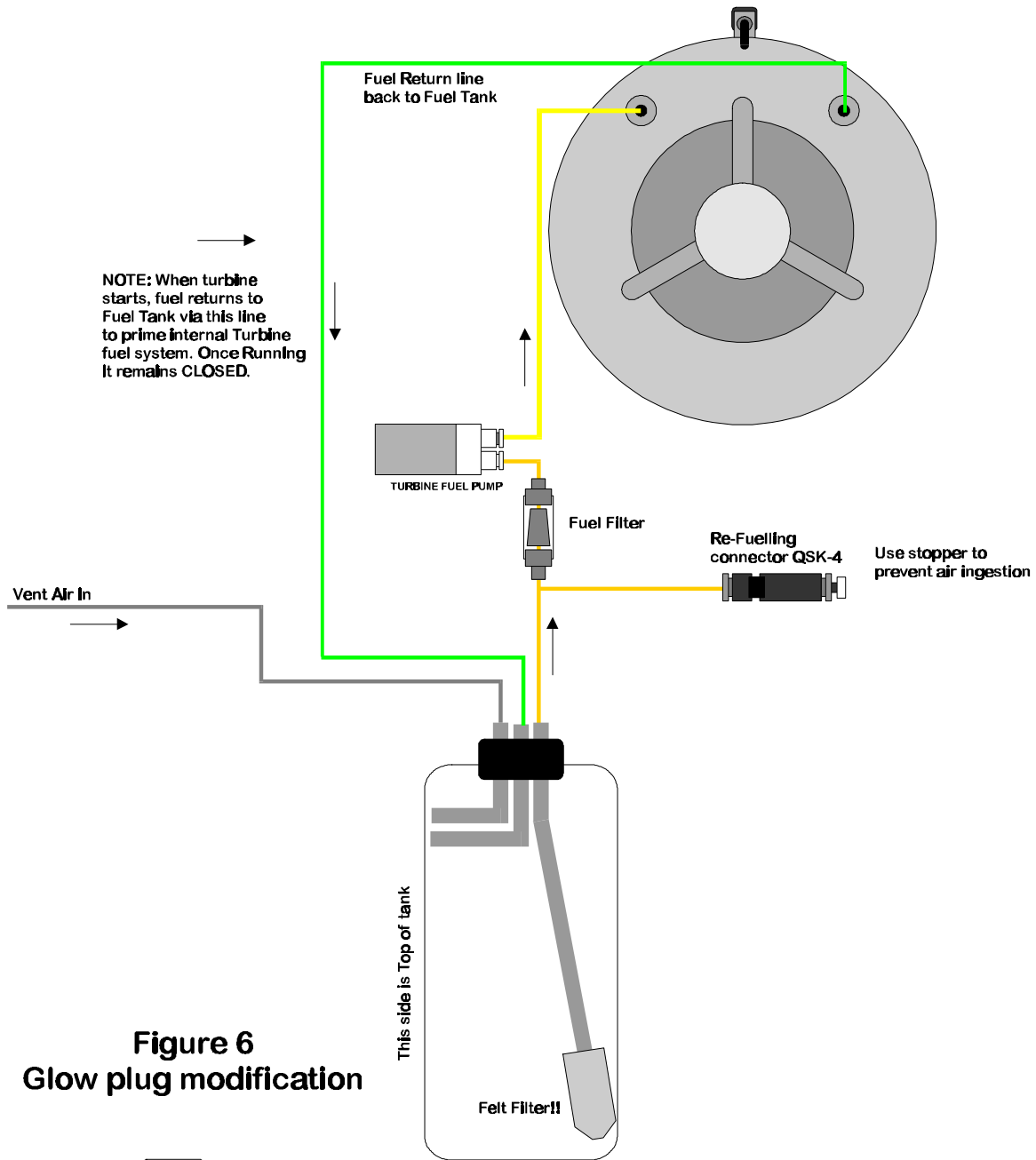
Figure 3: Fuel System Diagram with Spill-proof refueling
(Arrows indicate flow during RUNNING)



**Figure 4: Fuel System Diagram with single Fuel Tank
(Arrows indicate flow during REFUELING)**



**Figure 5: Fuel System Diagram with single tank.
(Arrows indicate flow during RUNNING)**



**Figure 6
Glow plug modification**

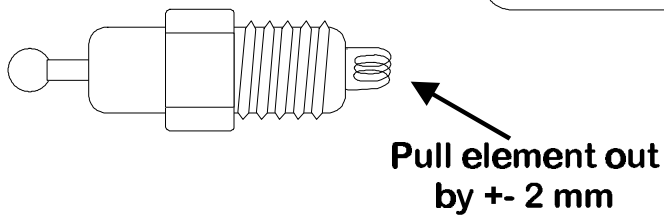
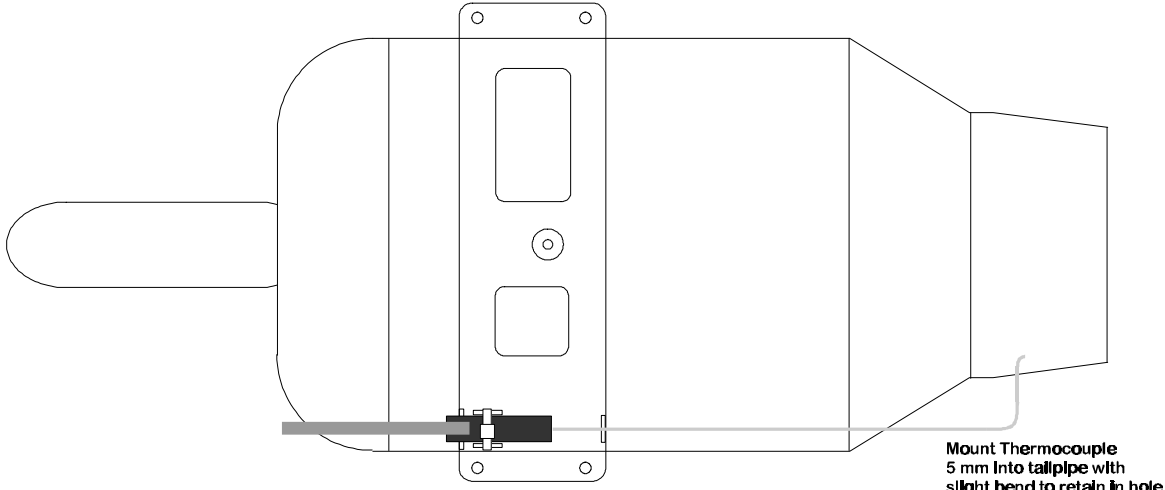


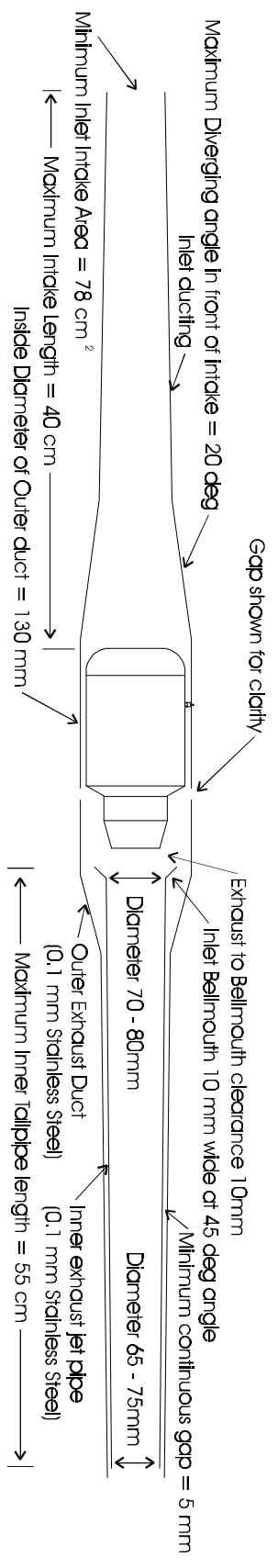
Figure 7
Thermocouple mounting



**Clip probe into tabs on
mounting straps and
secure with small cable tie**

**Mount Thermocouple
5 mm Into tailpipe with
slight bend to retain in hole**

Figure 8



Drawings not to scale!

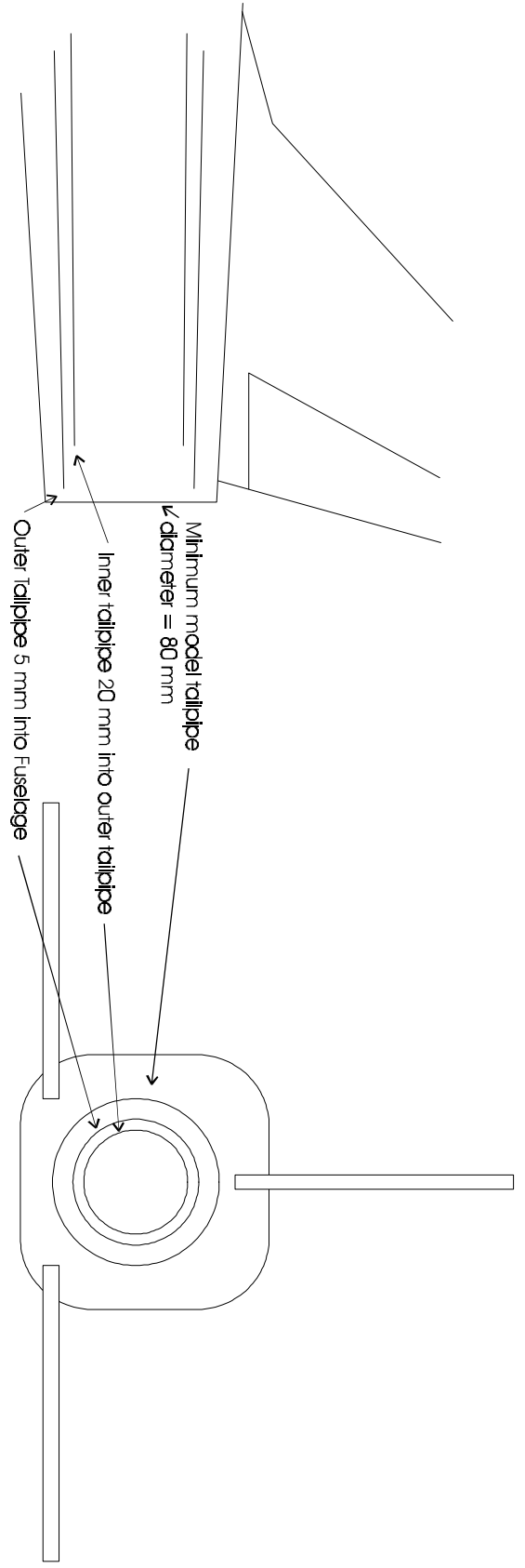
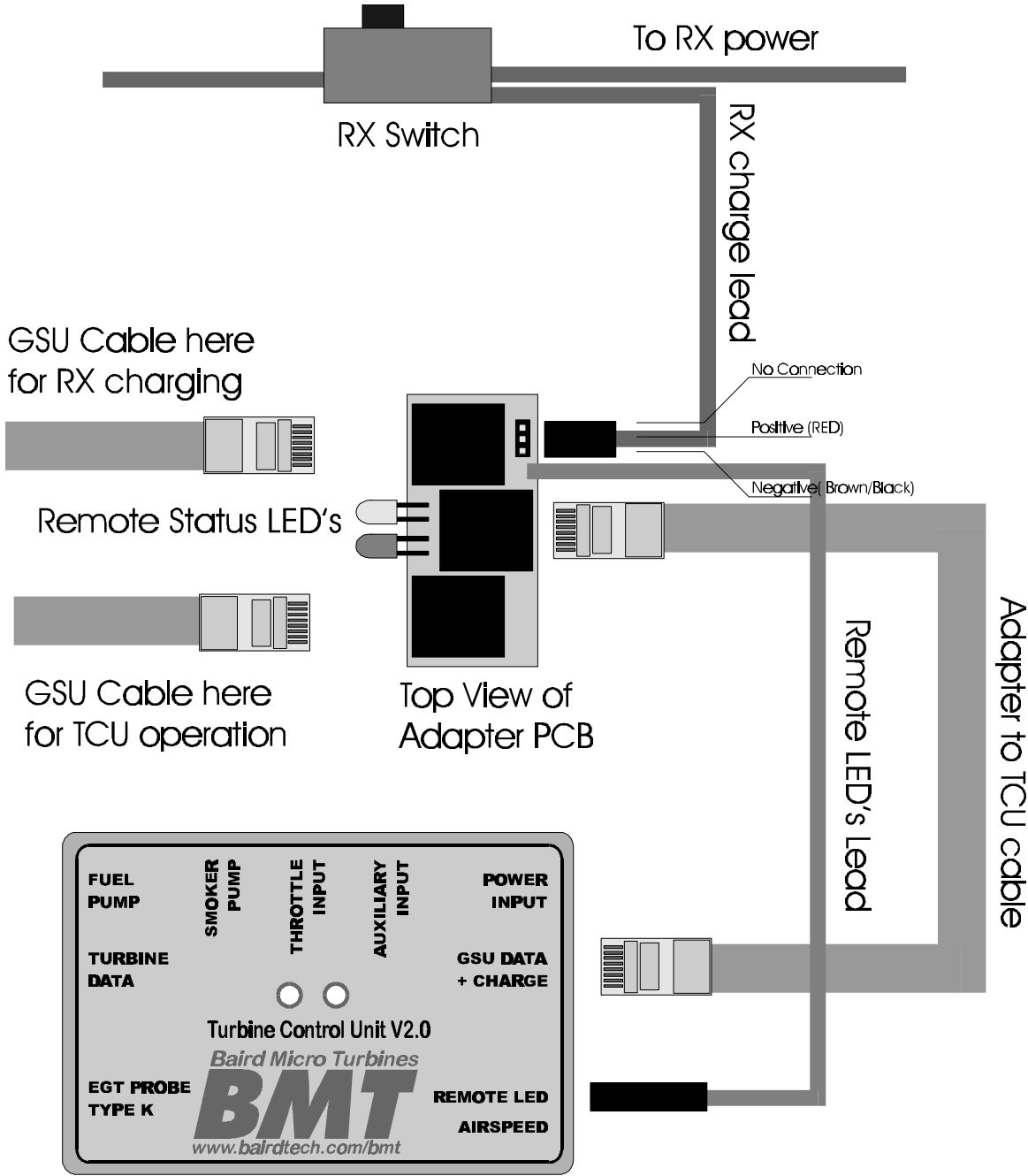


Figure 9
GSU Charging Adapter



Spare Parts listing

BMT Part NR	Description	Price US\$
BATT-01	Pump battery 2000mAH	
BATT-02	Pump Battery 2400mAH	
TCUV2KS-01	Turbine Control Unit V2 KS	
GSUV2-01	Ground Support Unit V2	
TTDC-01	Turbine/TCU Data cable	
TGDC-01	TCU/GSU Data cable	
PCST-01	Power Cable Starter/TCU	
FPKS-01	Fuel Pump KS	
SP-01	Smoker Pump	
FJKS-01	Fuel Injector Assembly	
PCDC-01	PC Data Interface Cable	
SAKS-01	Starter Assembly complete	
TPCBKS-01	Turbine PCB Assembly complete	
MSS-01	Mounting Strap Set	
TPKS-01	Thermocouple Probe KS	
FDCSW-01	Flight Data Center Software Windows 95/98/2000	
IMK-01	Injector Maintenance Kit	
KSFF-01	Fuel Filter	
ORK-01	Spare "O"-ring Kit.	
MANKS-01	Manual BMT160 KS	

Packing list BMT160 KS

QTY	Description	Checked
1	Turbine engine complete	
1	Turbine Control Unit	
1	Ground Support Unit	
1	Pump Battery NiCad 2000mAH	
1	Fuel Pump KS - Series	
1	Turbine/TCU Data Cable	
1	GSU/TCU Data Cable	
1	Starter/TCU Power Cable	
1	GSU/12 V Input Power Cable	
1	Thermocouple Probe	
1	Top Mounting Strap	
1	Bottom Mounting Strap	
2	Mounting Plate Top (5 holes)	
2	Retaining Plate Bottom (3 holes)	
1	Hex Key M2	
1	Spare Oval Injector Washer	
1	M2 Allen Cap Injector retaining screw	
2	Spare Injector Insert "O"-ring	
2	Spare Injector "O"-ring TOP	
2	Spare Injector "O"-ring BOTTOM	
2	Spare Starter Cup "O"-ring	
1	KS160 – Operators Manual	

