EMIT Dynamic Control

Installation and Testing Manual
Waukesha VHP Engines

Ignition ICM1 (20270-0003)
Governor (20310)
AFRC (20230)
Panel (1428X-XXXX)

September 2024

Contents

MOUNTING THE PANEL

Begin the installation by shutting down the engine, disconnecting battery power, and locking out all fuel sources

	Before welding, ensure that the area is clear of explosive gases and that no flammable liquid is present on the skid

	Before placing mount feet, ensure ample room is present to the left and behind the panel to provide space for the panel door to open and for plumbing of the pressure tubing

1. Weld the mount feet to the engine skid
2. Place the panel on top of the mount feet
3. Bolt the panel to the mount feet using no less than four 3/8” grade 8 bolts tightened to a torque of 33ft-lbs

STAINLESS TUBING CONNECTIONS

Stainless tubing can be connected through the side of the panel skirt or directly to the pressure sensor up under the rear of the panel. If the panel is configured to have tubing connected through the side of the panel skirt tubing labels will be placed on the skirt. To land the stainless tubing connection:

	When tightening the tubing connection, be sure to use two wrenches: one to tighten the nut and another to relieve stress from the pressure sensor or other components on the same tubing line

1. Insert the tube into the fitting to maximum depth
2. Rotate the tube fitting nut until finger tight
3. Tighten the tube fitting nut one and one-quarter turns from finger tight (TFFT)
4. Repeat for additional tubing connections

END DEVICE WIRING

1. Wire main panel power and ground as shown on the schematic to fuse F1 for power and the ground terminal block group for ground.
2. Digital input landings are shown on the schematic on double level terminal blocks. The lower level is connected to ground for use with two wire switches.
3. Thermocouples will be routed directly to the Brain and Brain+ (expansion) modules. Avoid routing thermocouples near signals that could be noise sources. Thermocouples can route up left cable channel(s) to avoid other wires.
4. Pressure sensors will be pre-wired if panel mounted. For remote mount sensors, route the harness back to the panel and terminate on the indicated double-level terminal block. Harness sensors will use a red wire for the power lead, which is the top level of the terminal blocks.
5. Note that manifold pressure sensors can route to either the AFRC or the Brain. Generally routing to the Brain is recommended unless there are not enough spare analog inputs.
6. When possible, attach drain wires to the ground blocks.
7. The digital out for Lube (DO-1) will be used for both engine and compressor pre-lube, if both lube pumps are present.
8. The Ignition power/comm harness, governor servo harness, and AFRC end device harnesses will run back to the panel and land as indicated in the panel schematic.

IGNITION MODULE INSTALLATION

REQUIRED COMPONENTS

Part Number	Description
14305-0003 OR:	ICM Mount kit , Waukesha 12 cylinder engines
65300-6005	ICM Mount kit, 3524
15653-0001 OR:	Coil rail harness, 12 cyl engines
15653-0002	Coil rail harness, 6 cyl engines
15651-0181	Coil rail pigtails (1 per cylinder)
20270-0002 OR:	ICM for 6 cyl engines
20270-0003	ICM for 12 cyl engines
15652-0001	Coil rail (1 for 6 cyl, 2 for 12 cyl)
14330-0002	Flanged coil (1 per cylinder)
14331-0009	Spark plug (1 per cylinder)
14332-0004	Spark plug extension (1 per cylinder)
13241	Threaded hall sensor
15628-0800	Hall sensor harness, 8 ft
13242	Magnetic pickup, 3”
15654-1200 OR:	12 ft mag pickup cable
15654-2000	20 ft mag pickup cable
15633-0501	ICM power / comm harness, 50 ft

INSTALLATION PROCESS

1. Begin by shutting down the engine and disconnecting battery power.

2. Install *spark plugs*, *candlesticks*, *coil gaskets*, and *flanged coils*. Be sure to gap each *spark* plug prior to installation. Champion recommends 0.012in for the RB77CC. If you don’t know what your gap should be, start at that value. When installing the flanged coils, make sure that the key in the connector is down aka toward the coil rail.

3. Remove the manifold bolt that is nearest the cooler from cylinder 2, 4, 6, 8, 10, and 12 (see picture below). Replace it with the bolt/washer/lock washer, spacer, and metal hold-off that is part of the coil rail, then install the coil rail and coil rail pigtails between the rail and coils. Make sure the *coil rail* connector is toward the **cooler,** the first closest connector on each rail to the main connector is cyl 1R or 1L. For 6 cylinder engines only one rail is used but the large connector still faces the cooler.

4. For 12 cyl engines: Bolt the *ICM1 Mounting Bracket* to the intake manifold near cylinder one.

5. For 6 cyl engines: Bolt the ICM1 mounting bracket to the side of the engine where the ESM was mounted

6. Bolt the *ICM1-16* or *ICM1-8* to the *ICM1 Mounting Bracket* that was just installed using supplied hardware and vibration dampeners. Run a ground wire from the lug/ring terminal on the exterior of the ICM1 to the engine block. This can be done with wire leftover from installation of other modules.

7. Connect the ICM1 to each of the *coil rails* using the *coil rail harness*. Secure the coil rail harness well to prevent wear from vibration.

    a. For 12 cyl engines: The short pigtail of the harness will go to the left coil rail.

8. Install the *hall sensor* in the cam timing pickup location on the top center of the engine on the cooler side. The *hall sensor* operates better with a larger gap than a mag pickup. Bottom the *hall sensor* out on the timing disc then back it off two full turns to start.

9. Connect the sensor to the *ICM1* with the *hall sensor harness*. The harness will connect to the box at the only 4-pin connection.

10. Install the *3" Mag pickup on the flywheel* and connect it to the *ICM1-16* with the *long mpu harness*. Mag pickups operate better with a smaller gap than hall sensors. Bottom the mag pickup out on the flywheel then back it off one full turn to start. Note that the flywheel MPU connection is the **right** three pin connector on the ignition module.

11. Connect the *ICM1* to the panel using the *power/comm harness*. After routing the harness into the panel, cut off the excess cable to prepare for termination. The connections in the panel will be shown in the panel drawing. Note that the power/comm harness has two sections and both have a red and black wire – check the panel drawing to see how both halves are connected.

⚠	The ICM1 power / comm harness has one 2-wire cable for power and ground and a 6-wire cable for other functions. The red/black of the 6-wire cable should not be connected to power and ground.

IGNITION SETUP

This is covered in the later section "TESTING AND STARTUP".

COIL WIRE REFERENCE

For reference or debugging, this table shows the connections from the board through to each coil. Note that the short part of the Y cable goes to the **left** rail on 12 cyl engines.

12 cylinders

Fire Order	Cylinder Name	ICM Board Pin	ICM Box Coil Connector Pin	Left Rail connector pin	Right Rail connector pin
1	1R	J2,1	J		A
2	6L	J1,7	F	F	
3	5R	J2,6	N		E
4	2L	J1,2	B	B	
5	3R	J2,3	L		C
6	4L	J1,4	D	D	
7	6R	J2,7	P		F
8	1L	J1,1	A	A	
9	2R	J2,2	K		B
10	5L	J1,6	E	E	
11	4R	J2,4	M		D
12	3L	J1,3	C	C	
POWER	POWER	J1,5 and J2,5	T	I	I

6 Cylinders

Fire Order	Cylinder Name	ICM Board Pin	ICM Box Coil Connector Pin	Rail connector pin
1	1	J1,1	A	A
2	5	J1,6	E	E
3	3	J1,3	C	C
4	6	J1,4	D	D
5	2	J1,2	B	B
6	4	J1,7	F	F
POWER	POWER	J1,5	T	I

WIRING GUIDELINES

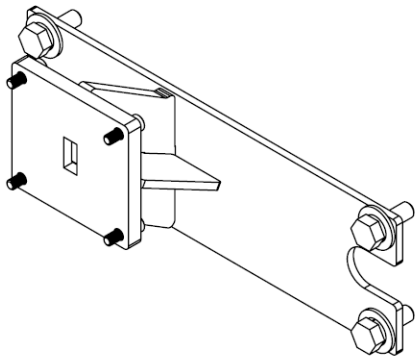
Standard wiring harnesses are constructed with FEP insulation and a FEP jacket rated at 200ºC. This product has excellent resistance to oils, aliphatic hydrocarbons, heat, weather, acids, alkalis as well as oxidation. This product also has superior abrasion and flame resistance. Harnesses are also available with an armored jacket. The following are important general guidelines for wiring the modules to the engine:

- Do not install the system with power applied.
- If not enclosed in conduit, wiring harnesses should be securely attached to the supporting structure using tie wraps, p-clamps, or mounting brackets.
- Long, unsupported wire runs should be avoided.
- Keep all wiring away from hot or moving parts and all ignition wires.
- All wiring splice connections should be soldered and protected with heat shrink tubing, except for thermocouples.
- Thermocouple wires should be spliced only when necessary, using approved procedures.
- Properly connect all wires before energizing the power connections.
- Care should be taken when making connections to the terminal blocks to allow for excess wire for the front cover to be folded back up and secured in place. This prevents strain on the connections.
- Shielding wire must be grounded to the available lugs inside the back of the enclosure or to shielding terminals.
- All electrical components must share a common ground.

Armored harnesses include a stainless steel overbraid. Use appropriate tools for cutting harness to length or removing excess overbraid material.

SPEED CONTROLLER INSTALLATION

1. Note: If engine already has an electric throttle actuator, skip to step 6.
2. Remove the existing governor. The throttle bodies will be reused.
3. Mount the servo bracket (17113-0015) to the engine using the supplied ½" x 1.5" bolts, washers, and lock washers.



4. Mount the servo motor to the bracket using the supplied four M8-1.25 bolts (14087-0007).
5. Install the supplied linkage between the servo motor and the right side throttle body. The linkage through the engine will be reused.
6. Attach the 10-pin harness to the servo and route back to the panel. The landing at the panel will be indicated in the panel drawing. Although the servo itself has ten pins, the actual harness only uses four pins. There will be a resistor present where the red wire lands in the panel.

Harness Pinout

Note that the harness will have a landing location at panel terminal blocks. The destination below shows where it ultimately ends up.

Servo Pin	Wire Color	Destination
A	White	Batt +
B	Shield or Yellow*	Ground
C	Green	Speed Pin 26 "Anlg out"
H	Black	Batt -
I	Red	Speed Pin 20 "TB Pos1"
J	Shield*	Ground

*Some harnesses don't have a Yellow wire. If Yellow is present it should be connected to ground, and shield should always be connected to ground. The actuator won't operate if shield is not connected to ground in some cases.

There should be a 182 ohm resistor installed between module pin 20-23, or at the panel terminal blocks between where the red wire lands and ground.

Mag pickup note

In most cases the ICM tach output (power/comm harness BLACK wire in larger cable) will be routed to the SPEED MPU input. It can route to either input, for example MPU+ comes from tach and MPU- is empty. This is generally covered in the panel drawing already.

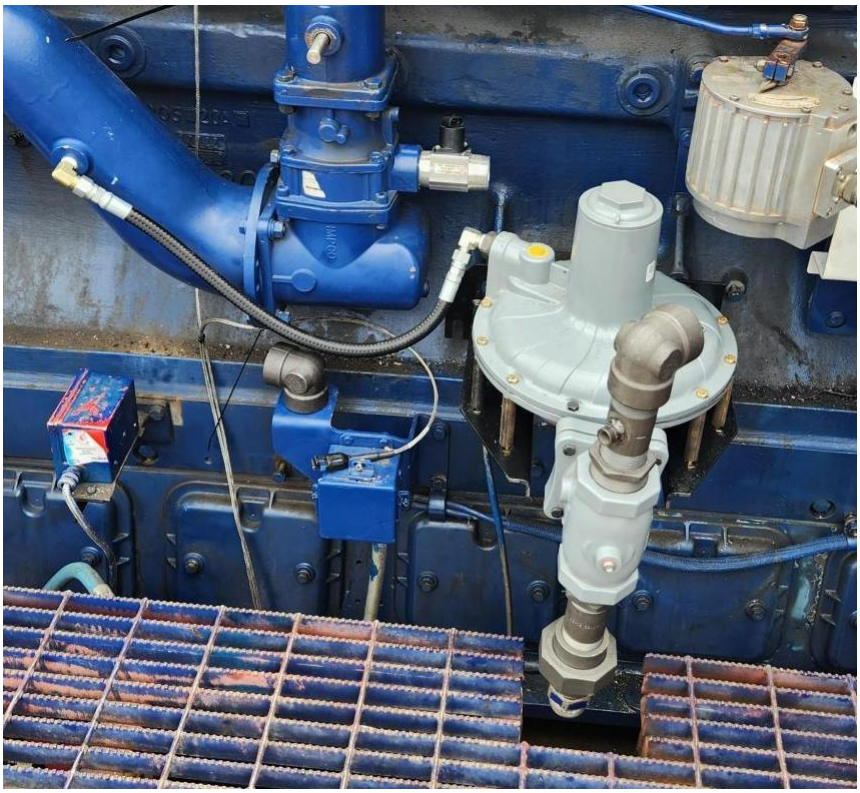
AFRC INSTALLATION

CS800 Regulator Kit

If the engine has Fisher 99 regulator(s), they will be reused with a simple DPV (digital power valve) change. If the engine has Mooney regulator(s), which are common with the ESM, they will be changed to CS800 regulators.

The CS800 regulator kit will have the relevant bracket to mount the regulator in the location of the old regulator.

Regulator mount location



Piping detail

THERMOCOUPLES

The ETS system uses Type-K thermocouples as inputs. The thermocouples should be placed very close to the catalyst element in a pre (upstream) and post (downstream) configuration. Once the thermocouples are inserted into the sample port, tighten the fittings to secure the thermocouples in place. Route the thermocouple wires back to the indicated landing point in the panel.

OXYGEN SENSORS

Following are the requirements for proper installation of the oxygen sensor:

- The oxygen sensor should be installed in the exhaust system between the engine and the catalytic converter and/or muffler.
- The mounting location should be as close to the engine exhaust manifold as possible.
- It is strongly recommended that the oxygen sensors are mounted just after the turbo outlet
- The sensor should be exposed to the unobstructed flow of the exhaust gases from all cylinders to be controlled by that sensor. Do not locate the sensor in a coupling or in a location where the exhaust gas flow is uneven due to obstructions or sharp bends.
- The sensor location chosen should allow for easy access.
- The location chosen should not subject the exterior shell of the sensor to an ambient air temperature greater than 350ºF.
- For optimum resistance to water intrusion, mount sensors so the exposed end of sensor is oriented at or above horizontal to prevent moisture accumulation.
- Do not mount vertical/above exhaust as the heat rise may damage harness.
- Do not mount directly below exhaust as condensation may damage sensor element.

If installing a post-catalyst oxygen sensor, it should be installed in a “necked” or “throttled” flow region after the catalyst to ensure proximity to well mixed exhaust gas with minimal interference from a flow boundary layer. Welding an 18 mm port to receive the oxygen sensor on the catalyst housing/silencer outlet neck (narrowest flow region of the post-catalyst exhaust system) is the preferred placement. However, installing a ½” NPT to 18 mm adaptor on an available port in the exhaust tailpipe is an acceptable alternative.

⚠	Drain wires are required to be secured to the shield terminal block of the AFRC Advanced or AFRC Lite if using the six-wire wideband sensor.

💡	Sensor replacement is recommended every 2,200 hours or as performance of sensor dictates.

A weld-on adapter may be required for sensor installation in exhaust systems with no available O2 port. To mount the adapter, drill and spot face a hole in the exhaust pipe at the selected location then weld on the 18mm adapter. A flat, smooth sealing surface is required to assure accurate readings. Air or exhaust leaks will impact sensor operation. After the adapter is installed, an 18mm x 1.5 tap should be run through to ensure proper thread contact on O2 sensor.

Figure 1. Oxygen Sensor Standoff

Item #13020

💡	For turbo-charged engines, a "standoff" is available to keep the sensor out of the direct exhaust stream because of the extreme heat (see Figure 1). Contact EMIT Technologies for more information.

⚠	Use only a moly-graphite based anti-seize (Loctite 51605) on the sensor threads. Any other anti-seize compound may poison the oxygen sensor or catalyst!

Route the three oxygen sensor harnesses (left, right, post) back to the panel and terminate on the terminal blocks indicated on the panel drawing.

💡	Marking each of the three harnesses with different color electrical tape before routing will help with harness identification at the panel. It helps to fully terminate the O2 harnesses before routing the DPV harnesses to prevent mixing the two.

DIGITAL POWER VALVES

See separate installation guide “14083-Wauk_7044_DPV_Retrofit_Procedure_Handwheel_v1.11”.

Route the two DPV harnesses back to the panel and terminate on the terminal blocks shown in the panel drawing.

OTHER SENSORS

MANIFOLD PRESSURE

The manifold pressure sensors will be installed directly on the intake manifold. Typically the harness will run back and connect to the AFRC. In some cases it will run back to the Brain instead – either option will work.

On the standard harness the red wire will route to 12v and the white wire will go to the input.

ENGINE OIL PRESSURE AND OIL TEMPERATURE

The engine oil pressure will typically use a 0-100 PSI pressure sensor and be installed directly on the engine block in an oil port. The oil pressure sensor will route back to the EMIT Brain module or another annunciator. The oil temperature sensor will similarly be installed in the block and routed back to the annunciator.

TESTING AND STARTUP

INITIAL VERIFICATIONS

1. Connect battery power and turn on the panel
2. Verify that all modules are powered and appear on the touchscreen.
3. Verify that all analog inputs and thermocouples have reasonable readings and do not show 'disconnect'.
4. From the home screen, select 'Brain State' then 'Faults' tab. This tab can be viewed (or the right box on this tab selected) to test digital inputs.
5. At "Settings" – "Brain" – "Outputs Status / Testing" – "Digital Out Testing", test the lube pump and valve digital outs to verify that the end device functions correctly.

SETUP

1. The panel should come pre-configured for the engine with default settings. If the engine modules have not been configured, go to "Settings" – "System / Global Settings" – "Engine Quick Setup". Then, select the cylinder count followed by the proper engine to fill in the default values.
2. Configure the kill levels on each thermocouple and analog input by selecting each gauge, selecting "Setup this Input", then setting the desired kill levels.
3. Verify that the normally open or closed is correct on each digital input under "Settings" – "Brain" – "Input Setup" – "Digital Inputs".
4. Check and adjust the no flow cycle times at "Settings" – "Brain" – "Input Setup" – "No Flow Proximity Switch"
5. Check the pre/post lube settings at "Settings" – "Brain" – "Outputs Setup" – "Pre/Post Lube Setup".
6. Check the idle and auto speed settings at "Settings" – "Speed Controller" – "Main Setup Wizard"
7. Make sure the ICM tachometer output is set up at "Settings" – "ignition" – "Engineering Setup". Set the "Tachometer Out Pulses Per Rev." to the number of flywheel teeth.
8. Verify ignition timing is set to engine manufacturer's specification according to the fuel gas analysis
9. On the AFRC home tab set the Valve Control to "Manual" then press "Home Valves". After the valve(s) home, set the valve control back to "Engaged"

IGNITION AND SPEED TESTS

1. From the Ignition home page, select "Testing" followed by "Engine Off Testing". For each cylinder:
    a. Select the cylinder to start a spark test
    b. Check the correct cylinder is sparking by disconnecting the coil and checking with a multimeter from A to B on the rail side.
2. If auto-crank is enabled, it is useful to disable auto-crank until this section is complete
    a. This is done at Brain – Outputs Setup – Crank Setup
3. Make sure fuel is shut off manually to the unit
4. Hit panel RESET. The Brain State should go to Pre-Lube followed by Running.
    a. If pre-lube cannot be done because of gas supply, temporarily turn it off under Brain – Outputs Setup – Pre/Post lube setup
    b. If the unit faults before the Brain state shows "Running", resolve that fault before continuing
    c. When the unit reaches "Running" the electric fuel valve should change to open
    d. When the unit reaches "Running" the ignition home page should show "Ready to start". If it does not, check the "SHDN" wire of the power/comm harness.
5. From the ignition home page, select 'Input Information'

6. Without fuel, crank the engine briefly and verify that the first two boxes turn green.
    a. If either the hall or MPU show ‘not moving’, the sensor may need to be screwed in slightly.
    b. If the first box turns green but the second does not, the configuration may not be correct. Under ignition main setup, the Input type should be set to “Cam MPU TDC”
7. Navigate to the Speed home page
8. The throttle position should show 0-1%.
    a. If not, check that the Speed control setup is using throttle type “Heinzmann… (10 pin)”
    b. Also verify that a 182 ohm resistor is present where the throttle harness lands in the panel
9. Once again, crank briefly and verify that the speed module sees RPM. The servo motor should go from closed to crank position.
    a. The speed module receives RPM from the Ignition tachometer wire. This lands at the panel at a terminal block and is routed to the Speed module.
    b. If the speed module is not showing RPM, first check that the main speed controller setup is set to the correct number of teeth (208). Then check that Settings – Ignition – Engineering Setup “Tachometer Out Pulses Per Rev.” is 208. Finally, check the power/comm harness black wire from the larger cable.
10. Press STOP on the panel
11. Turn auto-crank back on under Brain – Outputs Setup – Crank Setup
12. If pre-lube was disabled, re-enable it

ENGINE STARTUP

1. Allow fuel to the unit
2. Set the speed switch to idle
3. Select ‘Reset’ then ‘Start’. The pre lube cycle should run, followed by the crank cycle.
4. Watch the speed status and the ignition input status pages if the engine has trouble starting
5. Once the engine is running, verify timing with a timing light.
    a. If the timing light does not match the displayed timing, adjust the offset at “Settings” – “Ignition” – “Calibration”
    b. This is a one-time calibration, once they match it will be calibrated for all timing ranges.
6. Check the AFRC home page and verify that the O2 sensors are reading (once the thermocouples are reading and load delay ends). Once controlling, verify that the DPV is able to affect the O2 reading, and the reading reaches the target.
    a. If not controlling properly, first verify the DPV is working by changing to ‘Manual’ mode and moving up and down. This should make the O2 reading richer (open) or leaner (close).
    b. If the DPV is working but reaches a limit (full open or closed) without meeting the target, adjust the fuel pressure at the regulator.
7. Verify there are no misfires on each cylinder by selecting the spark durations on the ignition home screen.
8. The engine is ready to load.