6R80 ENGINE/TRANSMISSION PACKAGE

MoTeC has developed a general-purpose firmware ("Package") that provides integrated engine and transmission control of powertrains comprised of any engine mated to the Ford 6R80 automatic transmission. The 6R80 Engine/Transmission Package provides world class engine control, transmission control, and race functions for a seamless delivery of power through the renowned Ford automatic.

The 6R80 Engine/Transmission package is a single ECU solution for control of any engine mated to the Ford 6R80 transmission in your chassis of choice. A MoTeC M150 and RaceGrade 6 Channel Current Sensor provide the flexibility and power to complete your engine and transmission swap with confidence knowing you have one controller that can do it all.

The engine and race functions are based on functionality found in the MoTeC USA Drag package.

KIT CONTENTS (RG.KT.PV0207.01)

- **Hardware**
  - **M150 –** M150 ECU
  - **RG.DV.PV0170.01 –** RaceGrade 6 Channel Current Sensor
  - **M 12-1121K –** 6R80 Transmission Connector Kit
  - **M150 CONN KIT –** M150 ECU Connector Kit
  - **DT-12SK and DT-4SK –** RaceGrade 6 Channel Current Sensor Connector Kit
- **Licenses**
  - **23511 –** M1 LIC – MoTeC USA 6R80 Swap

  This license is required to run the 6R80 Engine/Transmission control package. This part number is also available separately.

GENERAL TRANSMISSION FEATURES

- Full control of all shift patterns available in the transmission. This includes sequential upshifts, sequential downshifts and skip shift downshifts. Several unique to MoTeC shift patterns are also provided. Refer to the sample base file for a full list of shift patterns.
- User selectable shifting schedules for Drive and Select Shift "Sport" mode switchable with driver switches or OE shifter.
- Manual shift scheduling available via two driver switches (up/down paddles).
- One-way clutch control.
- Closed loop torque converter lockup control targeting torque converter slip. Standard and Power On modes.
- Torque converter apply/release rates.
- Torque converter control adaptation.
- Torque converter lockup schedules.
- Line pressure control for steady state operation as well as each available shift pattern – including special conditions such as one-way clutch control.
- Line pressure apply/release rates.
- Adjustable calibration of Turbine Speed and Output Shaft Speed inputs, allowing for utmost accuracy of these critical speeds on a case per case basis.
- Drag race creep function using closed loop transmission brake control to allow precise entry into staging lights
- User accessible calibration of factory Shift Selector reported position to ensure accurate command of the system
- User defined transmission protection that allows forcing the transmission into neutral or activation of a warning light when parameters are met.

- Adjustable current control profiles for each transmission control element, including line pressure and torque converter.
- Adjustable shift element periodic prime pressures as well as steady state hold pressures.
- Dyno mode – settings to shift up to and hold a specific gear for dyno testing.
- Start in Second – ability to indicate when the driver wishes to start in second gear via a user defined input
- Anti-Flare logic to catch transmission flares to help prevent them from damaging transmission components.
- Shift inhibit function that will hold the current gear during rapid driver throttle lift off.
- Power Management – torque reduction tuning for each available shift pattern, as well as torque reduction and reintroduction rates to protect the transmission and adjust shift feel.
- Turbine Speed Matching – "throttle blipping" to ensure downshifts completely smoothly and accurately without dragging of the oncoming clutch during power off downshifts.
- Torque Limits – used to limit engine power when engaging Drive/Reverse or executing any downshift.
- Closed loop PID control during the clutch to clutch phase of all upshifts, including the turbine speed pull down phase.
- Closed loop PID control on all downshifts to control the turbine speed trajectory.
- Sequential downshifting management to ensure proper holding pressure is applied to the outgoing element on rapid downshifts.
- Gear Minimum – ability to indicate that the transmission should never shift below second gear.
- Gear Maximum – ability to indicate the maximum gear in the transmission.
- Automatic shift scheduling during coast down (rapid deceleration).
- Predictive shift scheduling of upshifts based on vehicle acceleration rate.
- Adaptive – "learning" to allow some adjustability for flares/binding as transmission ages.

TRANSMISSION UPSHIFT CONTROL

These are the features available for tuning each upshift on the transmission.

- Oncoming element base pressure.
- Oncoming element boost time.
- Oncoming element boost pressure.
- Oncoming element preparation hold time.
- Oncoming element open loop ramp.
- Oncoming element closed loop slip target.
- Oncoming element control time bias.
- Oncoming element pressure capacity increase.
- Outgoing element base pressure.
- Outgoing element rapid pressure decay time.
- Outgoing element open loop ramp.
- Outgoing element closed loop slip target
- Outgoing element control time bias.
- Delay indicating if outgoing or oncoming element needs to be phased relative to the other.
- Torque reduction in normal mode.
- Torque reduction in sport mode.
- Thresholds indicating shift progression and thresholds for power management.

TRANSMISSION DOWNSHIFT CONTROL

These are the features available for tuning each downshift on the transmission.

- Oncoming element base pressure.
- Oncoming element open loop ramp.
- Oncoming element boost time.
- Oncoming element boost pressure.
- Oncoming element nominal preparation hold pressure.
- Oncoming element preparation hold time.
- Outgoing element base pressure.
- Outgoing element open loop ramp.
- Outgoing element rapid pressure decay time.
- Delay indicating if outgoing or oncoming element needs to be phased relative to the other.
- Closed loop downshift turbine speed trajectory over time.
- Torque reduction.
- Thresholds indicating shift progression based on turbine speed trajectory as well as power management.

DRAG SPECIFIC FEATURES

- Driveshaft speed control allowing for ignition timing adjustments based on a user-defined driveshaft curve.
- Two stage mass flow based nitrous control with user-defined activate/reset parameters and ramp-in/ramp-out parameters for ignition/fuel compensations.
- Rolling launch functionality allows for turbo spool-up in a rolling launch scenario through use of variable boost aim and ignition timing adjustments.
- Differential ground speed traction control allowing for ignition timing adjustments and cut events based on user-defined allowable slip between driven and non-driven wheels.
- Auxiliary outputs with X & Y user-selectable axis of relevant package channels.
- Wastegate CO2 control with main target and scramble target functionality.

- Launch control with ignition timing adjustment functionality, engine speed limiting, and spool mode to aid in build-up of turbo speed on the launch
- Race Time channel for use of time-based functions/compensations following the launch
- Engine efficiency compensation system for exhaust back pressure.
- Selectable Engine Efficiency table load axis allowing for native AlphaN functionality to simplify ITB and turbo over trumpets tuning.

ENGINE CONTROL

- Applicable to port injected engines from 1 to 8 cylinders
- Configurable engine synchronisation modes for many common engine types.
- Configurable top dead centre for each cylinder allows for odd- fire engines
- Configurable ignition output pin for each cylinder allows for coil-on-plug or wasted spark and distributor ignition systems.
- Configurable on-board knock for each cylinder with up to 4 assignable knock sensors (hardware dependent)
- Physical settings for engine displacement, fuel density + molar mass, stoichiometric ratio, and injector characteristics allow for simplified engine start up prior to tuning.
- Dual bank lambda control supported; requires optional LTCD with Bosch LSU4.9 sensor or LTCD NTK with NTK sensor
- Configurable camshaft control from 1 to 4 cams, plus 1 switch camshaft
- Engine efficiency load based on either manifold pressure, throttle position, or a ratio of manifold pressure and ambient pressure
- Engine load modelling based on inlet manifold pressure and inlet manifold temperature or throttle position
- Control of 2 port injectors (peak and hold or saturated) per cylinder with tuneable contribution table
- Tuneable delay of the secondary injection system
- Built-in calibrations for common automotive sensors/actuators
- Transient fuelling compensations using a throttle rate of change-based calculation
- Entry/exit parameters for closed loop against transient events
- Turbocharger boost pressure control using standard pneumatic valves
- Turbocharger bypass valve control
- Control of 2 PWM Fans with parameters for independent and combined control of each fan
- Coolant pump control with after-run functionality
- Engine speed limiting with ignition and/or fuel cut
- Multiple fuel pump switched outputs
- Closed loop PWM fuel pressure control
- GPS acquisition and logging via CAN or RS232
- Intercooler temperature and spray control based on differential temperature with dedicated temperature sensor and switched pump output
- Differential oil temperature control with dedicated temperature sensor and switch pump output
- Engine Charge Temperature calculation to compensate for heat soak and cooling due to injection events
- Closed loop Idle control using ignition, drive by wire, actuation or an idle solenoid
- Flex Fuel support for use with an ethanol composition sensor to vary fuel properties, ignition timing, and boost levels with ethanol content.
- Closed loop alternator control
- Configurable security for multiple users
- ECU internal G-Force (acceleration) – longitudinal, lateral, vertical
- ECU CAN Receive for various MoTeC and RaceGrade devices such as E8xx expanders, LTC lambda modules, TC8 thermo couple amplifiers, and RG IMU inertial measurement units.
- Eight configurable switches and eight rotary switches (wired or CAN input) as well as CAN keypad functionality all mappable to race functions such as rolling launch, traction control, and launch control
- Single bank Drive by Wire throttle servo control
- Throttle Pedal sensor with translation table
- Vehicle speed measurement using wheel speed sensors, estimation or GPS
- Configurable warning system with light and CAN output
- Torque model for transmission integration.

SAMPLE M150 PINOUT

This is a sample pin out that demonstrates how the 6R80 transmission should be wired to the M1 ECU. Standard M1 wiring guidelines should be followed when wiring the rest of the engine control to the M1 ECU.

M150 Connector A – 34 Way

A1	AT5	Analogue Temperature Input 5	
A2	AT6	Analogue Temperature Input 6	
A3	AV15	Analogue Voltage Input 15	
A4	AV16	Analogue Voltage Input 16	
A5	AV17	Analogue Voltage Input 17	
A6	IGN9	Low Side Ignition 9	
A7	IGN10	Low Side Ignition 10	
A8	IGN11	Low Side Ignition 11	
A9	IGN12	Low Side Ignition 12	
A10	SEN_5V0_C	Sensor 5.0V C	
A11	LA_NB1	Lambda Narrow Input 1	
A12	LA_NB2	Lambda Narrow Input 2	
A13	KNOCK3	Knock Input 3	
A14	KNOCK4	Knock Input 4	
A15	DIG2	Digital Input 2	
A16	DIG3	Digital Input 3	-
A17	DIG4	Digital Input 4	-
A18	SEN_5V0_C	Sensor 5.0V C	
A19	SEN_5V0_B	Sensor 5.0V B	-
A20	LIN	LIN Bus	-
A21	RS232_RX	RS232 Receive	-
A22	RS232_TX	RS232 Transmit	-
A23	DIG1	Digital Input 1	
A24	BAT_NEG	Battery Negative	Ground
A25	BAT_NEG	Battery Negative	Ground
A26	SEN_0V_C	Sensor 0V C	
A27	SEN_0V_C	Sensor 0V C	-
A28	CAN3_HI	CAN Bus 3 High	
A29	CAN3_LO	CAN Bus 3 Low	
A30	CAN2_HI	CAN Bus 2 High	-
A31	CAN2_LO	CAN Bus 2 Low	-
A32	BAT_NEG	Battery Negative	Ground
A33	SEN_0V_B	Sensor 0V B	-
A34	SEN_0V_A	Sensor 0V A	-

SAMPLE M150 PINOUT

M150 Connector B – 26 Way

B1	HB9	Half Bridge Output 9	
B2	HB10	Half Bridge Output 10	
B3	UDIG8	Universal Digital Input 8	
B4	UDIG9	Universal Digital Input 9	
B5	UDIG10	Universal Digital Input 10	
B6	UDIG11	Universal Digital Input 11	
B7	UDIG12	Universal Digital Input 12	
B8	INJ_LS5	Low Side Injector 5	-
B9	INJ_LS3	Low Side Injector 3	-
B10	AV9	Analogue Voltage Input 9	-
B11	AV10	Analogue Voltage Input 10	
B12	AV11	Analogue Voltage Input 11	-
B13	BAT_POS	Battery Positive	Switched Power
B14	INJ_LS6	Low Side Injector 6	-
B15	INJ_LS4	Low Side Injector 4	-
B16	AV12	Analogue Voltage Input 12	
B17	AV13	Analogue Voltage Input 13	-
B18	AV14	Analogue Voltage Input 14	-
B19	BAT_POS	Battery Positive	Switched Power
B20	HB7	Half Bridge Output 7	-
B21	HB8	Half Bridge Output 8	-
B22	PH9	Peak Hold Injector 9	
B23	PH10	Peak Hold Injector 10	
B24	PH11	Peak Hold Injector 11	
B25	PH1	Peak Hold Injector 12	-
B26	SEN_5V_A	Sensor 5.0V A	-

SAMPLE M150 PINOUT

M150 Connector C – 34 Way

C1	HB2	Half Bridge Output 2	RaceGrade DT12S Pin 11 - SSB
C2	SEN_5V_A	Sensor 5.0V A	
C3	IGN1	Low Side Ignition 1	
C4	IGN2	Low Side Ignition 2	
C5	IGN3	Low Side Ignition 3	
C6	IGN4	Low Side Ignition 4	
C7	IGN5	Low Side Ignition 5	
C8	IGN6	Low Side Ignition 6	
C9	SEN_5V_B	Sensor 5.0V B	-
C10	NEG1	Battery Negative	Ground
C11	NEG2	Battery Negative	Ground
C12	IGN7	Low Side Ignition 7	
C13	IGN8	Low Side Ignition 8	
C14	AV1	Analogue Voltage Input 1	6R80 Connector Pin 6 (4.7K OHM Pull Up To C2) – Transmission Temp
C15	AV2	Analogue Voltage Input 2	
C16	AV3	Analogue Voltage Input 3	
C17	AV4	Analogue Voltage Input 4	
C18	HB1	Half Bridge Output 1	RaceGrade DT12S Pin 12 - SSA
C19	PH1	Peak Hold Injector 1	
C20	PH2	Peak Hold Injector 2	
C21	PH3	Peak Hold Injector 3	
C22	PH4	Peak Hold Injector 4	
C23	INJ_LS1	Low Side Injector 1	
C24	INJ_LS2	Low Side Injector 2	6R80 Connector Pin 8 - SSE
C25	AV5	Analogue Voltage Input 5	
C26	BAT_POS	Battery Positive	Switched 12V
C27	PH5	Peak Hold Injector 5	
C28	PH6	Peak Hold Injector 6	
C29	PH7	Peak Hold Injector 7	
C30	PH8	Peak Hold Injector 8	
C31	HB3	Half Bridge Output 3	RaceGrade DT12S Pin 10 - SSC
C32	HB4	Half Bridge Output 4	RaceGrade DT12S Pin 9 - SSD
C33	HB5	Half Bridge Output 5	RaceGrade DT12S Pin 8 - TCC
C34	HB6	Half Bridge Output 6	RaceGrade DT12S Pin 7 - LPC

SAMPLE M150 PINOUT

M150 Connector D – 26 Way

D1	UDIG1	Universal Digital Input 1	CRANKSHAFT POSITION
D2	UDIG2	Universal Digital Input 2	CAMSHAFT POSITION
D3	AT1	Analogue Temperature Input 1	
D4	AT2	Analogue Temperature Input 2	
D5	AT3	Analogue Temperature Input 3	
D6	AT4	Analogue Temperature Input 4	
D7	KNOCK1	Knock Input 1	
D8	UDIG3	Universal Digital Input 3	6R80 Connector Pin 1 (TSS)
D9	UDIG4	Universal Digital Input 4	6R80 Connector Pin 15 (OSS)
D10	UDIG5	Universal Digital Input 5	6R80 Connector Pin 4 (Selector)
D11	UDIG6	Universal Digital Input 6	Right Paddle
D12	BAT_BAK	Battery Backup	
D13	KNOCK2	Knock Input 2	
D14	UDIG7	Universal Digital Input 7	Left Paddle
D15	SEN_0V_A	Sensor 0V A	6R80 Connector Pin 5 – Transmission Temp 0V
D16	SEN_0V_B	Sensor 0V B	
D17	CAN_HI	CAN Bus 1 High	RaceGrade DT4S Pin 3
D18	CAN_LO	CAN Bus 1 Low	RaceGrade DT4S Pin 2
D19	SEN_6V3	Sensor 6.3V	
D20	AV6	Analogue Voltage Input 6	
D21	AV7	Analogue Voltage Input 7	
D22	AV8	Analogue Voltage Input 8	
D23	ETH_TX+	Ethernet Transmit+	WHITE/ORANGE
D24	ETH_TX-	Ethernet Transmit-	ORANGE
D25	ETH_RX+	Ethernet Receive+	WHITE/GREEN
D26	ETH_RX-	Ethernet Receive-	GREEN

SAMPLE PINOUT

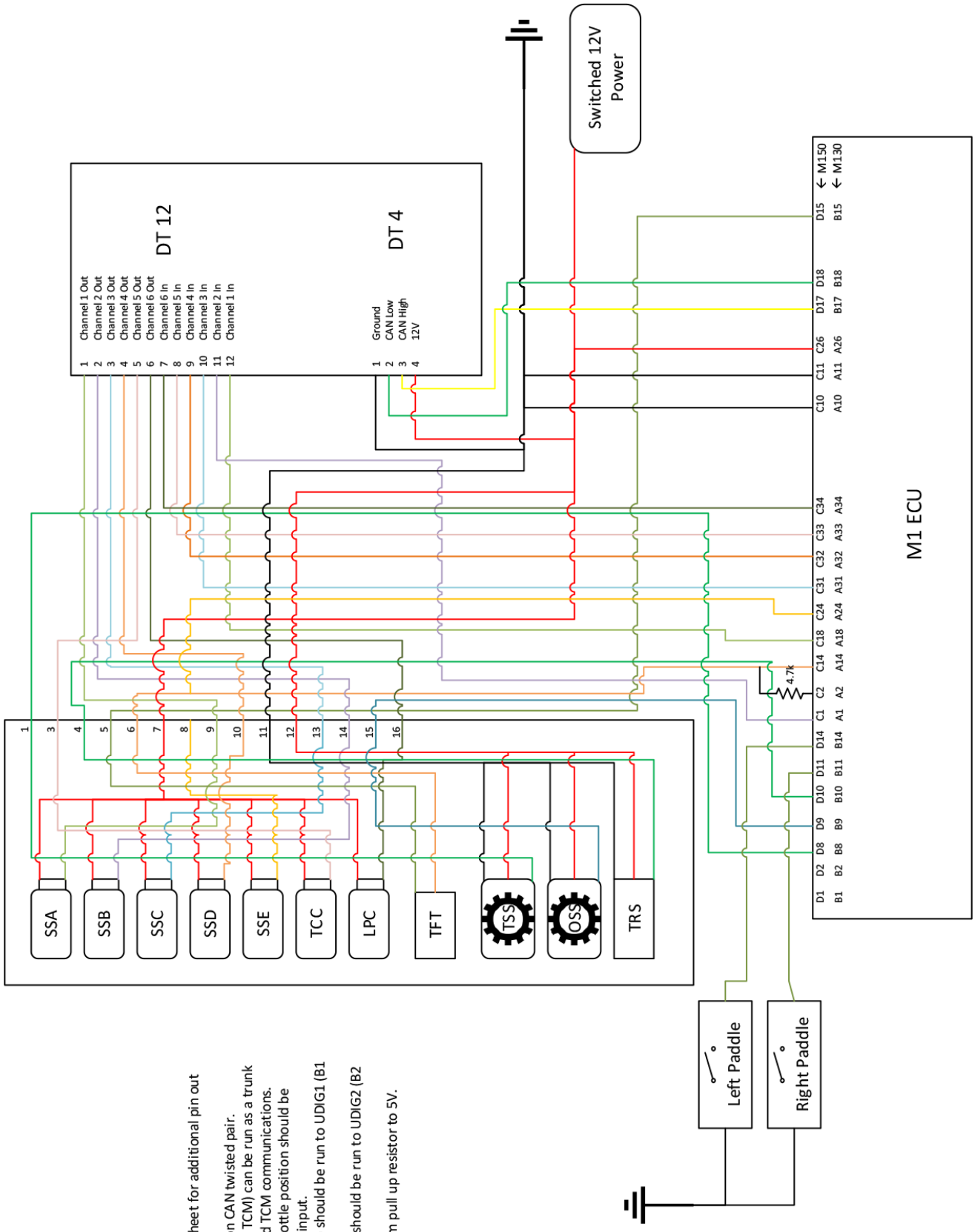
RaceGrade 6 Channel Current Sensor

DT12S

1	Channel 1	Channel 1 Out	6R80 Connector Pin 9 - SSA
2	Channel 2	Channel 2 Out	6R80 Connector Pin 14 - SSB
3	Channel 3	Channel 3 Out	6R80 Connector Pin 13 - SSC
4	Channel 4	Channel 4 Out	6R80 Connector Pin 10 - SSD
5	Channel 5	Channel 5 Out	6R80 Connector Pin 3 - TCC
6	Channel 6	Channel 6 Out	6R80 Connector Pin 16 - LPC
7	Channel 6	Channel 6 In	C34 – LPC
8	Channel 5	Channel 5 In	C33 – TCC
9	Channel 4	Channel 4 In	C32 – SSD
10	Channel 3	Channel 3 In	C31 - SSC
11	Channel 2	Channel 2 In	C1 – SSB
12	Channel 1	Channel 1 In	C18 – SSA

DT4S

1	Ground	Ground	Ground
2	CAN Low	Can Bus Low	M150 D18
3	CAN High	Can Bus High	M150 D17
4	12V	Switched Power	Switched Power



Notes:

- Refer to M130 or M150 datasheet for additional pin out details.
- 120 ohm resistor is required on CAN twisted pair.
- Additional ECU (if using M130 TCM) can be run as a trunk off the CAN Bus for CAN-based TCM communications.
- Additional sensors such as throttle position should be wired to any available Analog input.
- Engine Speed reference (REF) should be run to UDIG1 (B1 on M130).
- Cam sensor reference (SYNC) should be run to UDIG2 (B2 on M130).
- TFT Sensor requires a 4.7k ohm pull up resistor to 5V.