

T3RRA



2 | **COMMAND System Overview**

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Contents

2.1 | System Architecture

- Theory of Operation

 - Manual Control Mode

 - Automatic Control Mode

2.2 | Supported Implement Types

- Implemented and Tested Machine Profiles

- Machine Profiles Currently In Testing

2.3 | GNSS Receiver & IMU Compatibility

- NMEA 2000 (CANBUS)

- NMEA 0183 (RS232 Serial)

- John Deere StarFire TM

- Compatible Cross-slope / Roll / Tilt Sensors

2.4 | Tractor / Electrohydraulic Compatibility

2.5 | Selecting System Components

- Harnessing Compatibility

- Base COMMAND Components

- Optional COMMAND Components

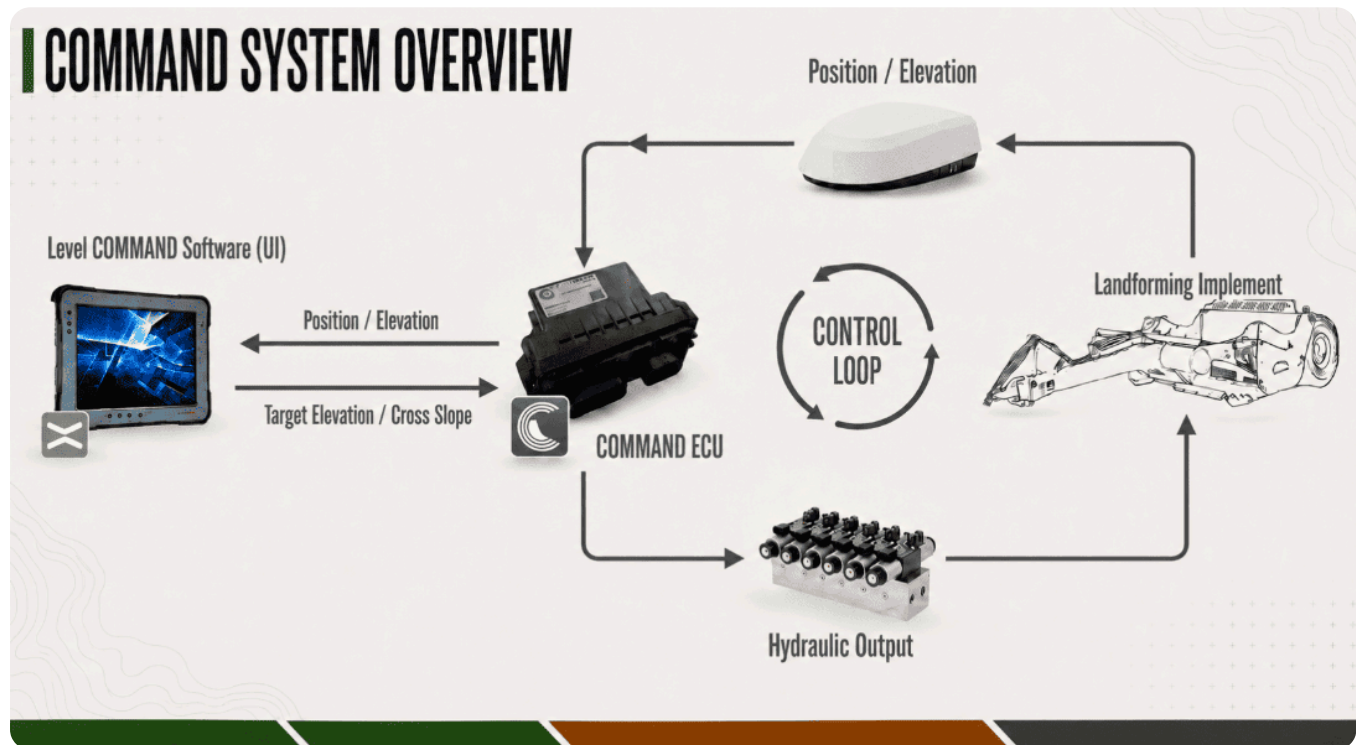
2.1 | System Architecture

Theory of Operation

COMMAND is an electronic control system designed by T3RRA consisting of an Electronic Control Unit (ECU) along with a harnessing system to interface with different sensors, hydraulic and tractor systems.

Once installed and configured, the ECU acts as both a control system and interface. It will communicate with a PC running T3RRA software, the earthmoving implement and sensors providing real-time feedback on the position of the implement, and tractor diagnostic data where available.

Level COMMAND can then control the implement based on your current position and design elevation, while satisfying constraints e.g. cut depth limits.



Manual Control Mode

In Manual Control Mode, and also when the system arming switch is deactivated, **COMMAND** is Disengaged and any prescribed elevations sent to the ECU will not result in activation of hydraulics. Hydraulic outputs can still be activated using a connected joystick or tractor SCV levers. These will function regardless of whether **COMMAND** Automatic Control is Disengaged or Engaged.

Automatic Control Mode

Once the operator has Armed the system and Engaged Automatic Control Mode, the ECU activates hydraulic outputs based on:

- Prescribed elevation

- Current elevation
- Calibration parameters
- Tracking sensitivity
- Tracking/acquire thresholds

While Engaged, joystick movement can override automatic control. Depending on configuration, joystick movement can either Disengage Automatic Control Mode or Momentarily Disengage control until the joystick returns to centre.

2.2 | Supported Implement Types

-  **COMMAND** machine profiles are used to store all configuration settings for that particular implement including GNSS input selections, valve configuration, calibration and tuning values etc.

Implemented and Tested Machine Profiles

COMMAND currently has the following machine profiles available for selection on the ECU:

Machine Profile	Controlled Functions	Example Usage
Single Scraper - Height	Function 1 - Height	A bucket scraper with single proportional height control valve and a single GNSS receiver
Single Scraper - Height & XSlope	Function 1 - Height Function 2 - XSlope / Tilt	A bucket scraper with a single proportional height and single proportional tilt control valve fitted with a single GNSS receiver and single inertial measurement unit (IMU)
Single Ditcher - Height	Function 1 - Height	A V-ditcher with a single proportional height control valve and a single GNSS receiver.

Machine Profiles Currently In Testing

 Machine profiles listed below are currently under development and may become available in future software releases.

Machine Profile	Controlled Functions	Example Usage
Single Ditcher - Height & Pitch	Function 1 - Height Function 2 - Pitch	A tile plow with a single proportional height, single proportional pitch control valve, single GNSS receiver and single inertial measurement unit (IMU).
Tandem Scrapers - Height	Function 1 - Height 1 Function 2 - Height 2	Two bucket scrapers in tandem, each with a single proportional height control valve and single GNSS receiver.
Single Scraper - Dual Height	Function 1 - Height	A bucket scraper with a single proportional height control valve but two GNSS receivers (One on the left of the implement, one on the right)
Single Scraper - Height (Dual Cylinder)	Function 1 - Height Left Function 2 - Height Right	A bucket scraper with dual proportional height control valves (controlling left and right height separately), and two GNSS receivers (left and right). Maintains blade angle to allow manual X-Slope / Tilt operation.
Single Scraper - Height & XSlope (Dual Cylinder)	Function 1 - Height Left Function 2 - Height Right	A bucket scraper with dual proportional height control valves (controlling left and right height separately), and two GNSS receivers (left and right).

2.3 | GNSS Receiver & IMU Compatibility

The requirements below outline the important components and considerations for using a GNSS receiver with **COMMAND**.

- StarFire RTK, NMEA 0183 Fixed RTK over RS232 serial, or NMEA 2000 Fixed RTK output over ISOBUS/CANBUS.
- Suitable adapters are available to connect RS232 or CANBUS and 12V external power to the **COMMAND** harnessing system.
- Ruggedised and suitable for earthmoving machine control applications.

 Receivers being used with **COMMAND** must be capable of RTK positioning calculations.

NMEA 2000 (CANBUS)



COMMAND is able to interface with GNSS receivers supporting NMEA 2000 standard output over ISOBUS/CANBUS for position feedback including but not limited to Case Vector Pro, New Holland PLM Cygnus & Trimble NAV 900/960 receivers.

Supported NMEA 2000 PGNs

- **129029** - GNSS Position Data
- **129539** - GNSS DOPs
- **129025** - Position, Rapid Update
- **129026** - COG & SOG, Rapid Update
- **129028** - Altitude Delta, Rapid Update

Position Update Rate

A minimum position update rate of 5 Hz is required. **10 Hz** is recommended.

NMEA 0183 (RS232 Serial)

COMMAND is able to interface with any receiver capable of providing NMEA 0183 standard sentences over RS232 serial for position feedback. The sentences below are required at a minimum for usage with **COMMAND**.



Required Sentences

- **GGA** - Time, position, and fix related data
- **GSA** - GNSS DOP and active satellites
- **VTG** - Actual track made good and speed over ground

Optional Sentences

- **RMC** - Position, Velocity, and Time
- **ZDA** - UTC day, month, and year, and local time zone offset

Position Update Rate

A minimum message rate of 5 Hz is required. **10 Hz** is recommended.

RS232 Baud Rate

The RS232 baud rate can be selected in **COMMAND** as 19200, 38400, 57600, and 115200 bps. A baud rate of **38400** is recommended.

John Deere StarFire™

COMMAND is able to interface with all modern StarFire receivers over ISOBUS/CANBUS for position feedback, including StarFire 3000, 6000, 7000 & 7500 models.



Differential GNSS or SF corrected signals e.g. SF3 are NOT considered suitable for implement position feedback as position accuracy and repeatability are insufficient.

Compatible Cross-slope / Roll / Tilt Sensors

For users making use of Cross-slope control using the **COMMAND** ECU's second output function, we recommend the use of the **T3H-E003** COMMAND Inclination Sensor – TARS-B to ensure that the angle sensor being used is robust and accurate for automatic implement control.

T3H-E003 - COMMAND Inclination Sensor

A TARS-B inertial measurement unit configured by T3RRA can be used to provide reliable feedback on the pitch and roll angle of the implement and can be mounted on the scraper for automatic Cross-slope control when using receivers such as Case IH Vector Pro or Trimble NAV 900.



StarFire™ TCM (Terrain Compensation Module)

COMMAND can make use of the in-built StarFire TCM, which provides feedback on pitch and roll angle of the receiver. The StarFire TCM can be selected as a Cross-slope / Tilt sensor but we cannot guarantee the accuracy / bias drift of the sensor and generally recommend the use of **T3H-E003** shown above.



2.4 | Tractor / Electrohydraulic Compatibility

COMMAND can make use of either in-built rear tractor electrohydraulic valves, commonly referred to as SCVs (Selectable Control Valves) or auxiliary remotes, or externally mounted electrohydraulic valves.

For each valve type, **COMMAND** is able to provide two raise and lower functions for automatic control of function 1 (e.g. height) and function 2 (e.g. cross-slope / tilt). For CANBUS based valve types, any available SCVs/Remotes will be available for selection.

For proportional solenoid, Analog Voltage (0-5V) and Danfoss PVE types, the number of selectable outputs is limited to the number of available physical outputs on the ECU suitable for analog voltage laser inputs or external EH valves.

Valve Interface	Description	Applicable Valve Adapter/s	Suitable example tractors/valves
<i>JD CAN</i>	COMMAND can communicate directly with John Deere SCVs over CANBUS, sending flow requests that will be enacted by the John Deere tractor hydraulic system.	N/A	Most modern John Deere tractors, e.g. 8R, 8RT, 9R, 9RT, 9RX.
<i>J1939</i>	COMMAND can communicate directly with the T3RRA VM or other compatible hydraulic controllers using the J1939 messaging standard.	N/A	Challenger tracked machines

Valve Interface	Description	Applicable Valve Adapter/s	Suitable example tractors/valves
<i>Fendt SCR/S4/MT</i>	COMMAND can communicate directly with Fendt SCVs over CANBUS, sending flow requests that will be enacted by the tractor hydraulic system.	Use T3H-V005 and S/111 valve adapters.	Fendt SCR, S4 and MT models where the SCV control bus is separated from the ISOBUS.
<i>Fendt ONE</i>	COMMAND can communicate directly with Fendt SCVs over CANBUS, sending flow requests that will be enacted by the tractor hydraulic system.	Use T3H-V005 valve adapter.	Fendt Gen 7 / ONE tractor models
<i>Analog Voltage (0-5V)</i>	COMMAND can provide 0-5V analog voltage signals suitable for John Deere legacy proportional SCV controller or Case IH / New Holland 0-5V EHR controller inputs.	Use T3H-V001 valve adapter.	Case 0-5V EHR inputs or John Deere legacy proportional laser inputs.
<i>Proportional Solenoid</i>	COMMAND can provide closed-loop PWM signals suitable for controlling external proportional solenoid valves requiring maximum flow current of less than 2 Amps.	Use T3H-V002 and T3H-V003 valve adapters.	Scraper systems using external proportional solenoid valves such as Eaton Vickers, Rexroth or Hydac.
<i>Danfoss PVE</i>	COMMAND can provide 0-Vs ratiometric voltage signals as well as power supply suitable for controlling external Danfoss PVEM, PVEA, PVEH and PVES valves.	Use T3H-V002 and one of T3H-V006 or T3H-V007 valve adapters.	Scraper systems using external closed-loop proportional valves such as Danfoss PVEM, PVEA, PVEH or PVES.

2.5 | Selecting System Components

- ✔ **Correct component selection is important for reliable installation and operation of the COMMAND system. Harnessing requirements will vary depending on tractor model, implement configuration, GNSS receiver type, and hydraulic interface. For assistance selecting compatible components, use the COMMAND kit picker at t3rra.com or contact T3RRA.**

Factors that will affect harnessing requirements include:

- Tractor brand
- Tractor model
- Scraper brand
- Scraper model
- GNSS receiver model
- Available Electrohydraulic Valves

Harnessing Compatibility

The **COMMAND** harnessing system has been designed to allow us to leverage existing customer and dealer knowledge of tractor and implement harnessing systems. We can then take advantage of this familiarity on the technical support front, while leveraging the fact that dealers also possess many of these parts in stock at-the-ready.

Typical CNH Components

SKU / Part No.	Name
115-0172-397 OR 115-0172-398 OPTIONAL POWER	Constant Power Harness (Row Crop) OR Constant Power Harness (Articulated)
115-7100-009 OR 115-7100-010 REQUIRED	Front Extension Wiring Harness Kit
115-7100-005 REQUIRED	Cable Adapter Terminator Gen I ISOBUS
92179218 OR 92317566 REQUIRED IF NO ISO IBBC PRESENT	Row Crop Tractor ISO Connector OR Articulated Tractor ISO Connector

Typical John Deere Components

SKU / Part No.	Name
BPF10403 OR BPF10404 OPTIONAL	Constant Power Harness (Row Crop) OR Constant Power Harness (Articulated)
BPF11117 REQUIRED	Front Extension Wiring Harness Kit (including terminator module)
RE174725 OR RE174726 REQUIRED IF NO ISOBUS PRESENT	GreenStar™ Ready Field Installation Kit (Rowcrop) OR GreenStar™ ISO Implement Connector Field Installation Kit (Articulated)

SKU / Part No.	Name
BPF12658 REQUIRED IF USING STARFIRE GNSS	Implement Receiver Wiring Harness Kit
BPF10547 RECOMMENDED	iGrade Counterbalance Valve kit - highly recommended if the implement has no existing counterbalance mechanism

Base COMMAND Components

 The components below are required for a base **COMMAND** installation.

SKU / Part No.	Name
T3H-E001	COMMAND ECU – Controller Only
T3H-L001	COMMAND ECU Licence – Licence Only
T3H-C002-1	COMMAND ECU Adapter - CAN & Analog V2
T3H-C003	COMMAND Arm/Engage Switch Adapter
T3H-C004	COMMAND Arm/Engage Switch
T3H-C005	COMMAND ISOBUS/Ext Breakout Adapter
T3H-C006	COMMAND Cab Breakout Adapter
T3H-C008	COMMAND Cab/Ext Extension Adapter
T3H-T001	Tablet Serial Interface Adapter (RA 4m)

Optional COMMAND Components

 Components listed below are optional for **COMMAND** and will only be required for certain tractor models, scraper models, GNSS receivers, Tilt sensors or Electrohydraulic valves.

SKU / Part No.	Name
Tractor Harnessing	
T3H-F001	Cab Convenience Power Adapter
T3H-F002	External Loose End Power Adapter
T3H-F003	COMMAND Inline Fuse Adapter
T3H-J001	COMMAND Joystick Adapter – 4m Extension
T3H-M001	COMMAND J1939 Diagnostic Adapter (Green)
T3H-T002	Tablet Serial Interface Adapter (RA 6m)
T3H-V001	COMMAND Legacy Analog Output Adapter
T3H-V002	Valve Adapter – 6m Extension
T3H-V003	Valve Adapter – Prop. Solenoid (2-way DT)
T3H-V005	COMMAND Tractor CAN Valve Adapter
Implement Harnessing	
T3H-E003	COMMAND Inclination Sensor – TARS-B
T3H-G001	COMMAND NMEA Extension Harness (8m)
T3H-G002	COMMAND Impl Adapter – NAV-900 / Ag372
T3H-G003	COMMAND Impl Adapter – Emlid Reach RS2/RS2+/RS3
T3H-G004	COMMAND Trimble NMEA Output Adapter
T3H-G007	COMMAND NMEA Extension Harness (12m)
T3H-S001	COMMAND Impl Adapter – Stub Junction
T3H-S003	COMMAND Impl Adapter - TARS Extension