

**TR200 DRIVE WITH ELECTRO-MECHANICAL BYPASS SYSTEM****TR200 DRIVE STANDARD FEATURES****The TR200 Trane Drive**

The TR200 Drive Series is a microprocessor-based, high frequency IGBT-based, PWM AC drive with control functions and software designed solely for the unique needs of HVAC systems. The TR200 Drive uses state-of-the-art Voltage Vector Control to supply full rated motor voltage at rated load and frequency, full motor performance without derating, high efficiency for both drive and motor, and a nearly perfect output sine wave. The diode-bridge rectifier and DC-link reactor provide a high displacement power factor at all speeds and loads and minimize power line harmonics. The TR200 Drive utilizes a common user interface for all units.

**Input Line Conditioning**

A dual, 5% DC-link reactor on the positive and negative rails of the DC bus is standard equipment on the TR200 Drive. This reactor reduces the level of harmonics reflected back into the building power system without causing a voltage loss at the drive's input and reducing efficiency as an external AC line reactor would. This reactor also improves input power factor. The reactor is non-saturating (linear) to provide full harmonic filtering throughout the entire load range. In performance, the DC-link reactor is equivalent to a 5% AC line reactor.

**Input EMI and RFI Filtering**

All TR200 Drives are designed to contain and control EMI and RFI to stringent European standard EN 61800-3. The Class A rating for the FCC rule that is commonly specified for drives has to do with commercial and industrial environments. Our Standard Class A2 filter is related to industrial environments.

**Slip Compensation**

The TR200 compensates for the motor slip by giving the frequency a supplement that follows the measured motor load keeping the motor speed almost constant.

**Output Carrier Frequency**

By using IGBTs, the TR200 Drive can employ high switching frequencies, so the motor current is practically sinusoidal. Audible motor noise can also be minimized by adjusting the switching frequency. These frequencies can be set or adjust themselves automatically to fit the application.

**Galvanic Isolation of Control Terminals**

All control terminals and output relay terminals are galvanically isolated from the power line. This means the drive controller is completely protected from the input current. The output relay terminals require their own grounding. This isolation meets the stringent protective extra-low voltage (PELV) requirements for isolation and ensures safe connection to building management systems.

**Adjustable Acceleration / Deceleration Rates**

The TR200 Drive can provide four individually controlled sets of acceleration/deceleration rates each from 1 to 3600 seconds. The shape of these curves may be automatically contoured to prevent tripping. The TR200 shall also provide an S-Curve shaped acceleration/deceleration ramp.

**SELF-PROTECTION AND RELIABILITY FEATURES****Input Power Line Protection**

Power line voltage surge protection is provided by means of input Metal Oxide Varistors (MOVs). This protects the diodes in the TR200 Drive's 3-phase full wave diode bridge. The DC-link reactor also acts to reduce input current caused by power line disturbances.

**Loss of Input Signal Protection**

Upon a loss of a control signal the TR200 Drive provides multiple options to select for the proper protection. The drive can be sent to a default speed, use the recent value, stop and/or send an alarm.

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### **Loss of Power or Phase Protection**

The TR200 Drive is equipped with an automatic sustained power or phase loss circuit. The TR200 Drive will provide a full rated output with an input voltage as low as 90% of the nominal. The drive will continue to operate with reduced output with an input voltage as low as 164 volts for 208/230 volt units, 313 volts for 460 volt units, and 394 volts for 600 volt units.

### **Overcurrent Protection**

Adjustable from 0 to 110% of the TR200 Drive's rated current (factory set at 110%). If during acceleration the current required to accelerate the load exceeds the current limit, the TR200 Drive will stop accelerating until the motor current is reduced to normal levels, at which time the load will continue to accelerate at the rate set by the acceleration time.

### **Advanced Motor Protection**

The TR200 Drive features integrated electronic, thermal motor protection. The VFD calculates the motor temperature based on current, frequency, and time. This system allows for changing cooling conditions as speed and load vary. The drive can predict motor overheating and reports a % of thermal load.

### **Automatic High Ambient Derate**

If the ambient temperature exceeds the normal limit, the drive can be set to warn of its overtemperature and continue to run, keeping the HVAC system functional. To control its temperature, the drive will reduce the output carrier frequency and then, if necessary, reduce the output current.

### **Automated Frequency Avoidance and Lockouts**

For applications where it may be necessary to avoid specific frequencies due to mechanical resonance problems in the driven equipment, the TR200 Drive, with its Critical Frequency Lockout Function, makes it possible to set up to four different frequency ranges which will be avoided during operation of the drive. This feature can be programmed by simply activating the feature and pushing OK at the top and bottom points that you wish to avoid.

Each critical frequency setting can avoid a frequency band which is from 1 to 100 Hz wide. If the reference signal defines that the TR200 Drive is to operate within this critical frequency range, the critical frequency lockout function will keep the drive operating continuously within this range.

When the frequency reference signal rises above the critical frequency maximum limit, the TR200 Drive will allow the motor to accelerate through the critical frequency at the rate set by the acceleration rate.

### **Instantaneous line-to-line and line-to-ground overcurrent trips**

TR200 monitors if there is a discharge from the output phases to ground, either in the cable between the adjustable frequency drive and the motor or in the motor itself.

**Short Circuit Protection:** The TR200 Drive provides inherent short circuit protection with a very fast acting fault trip circuit by sensing current on all three drive output phases. The use of insulated gate bipolar transistors (IGBT) in the TR200 Drive means very high-speed switching and rugged performance.

**Automatic Restarts:** The TR200 Drive can be automatically restarted up to 20 times or infinitely at 0 to 600 second intervals. If the application causes the drive to trip more than the number of trials set, the drive will stop operating and display the fault on the display screen. A manual reset will be required by means of the reset key, a digital input, or EIA-485 command. In cases of severe trips, as a safety feature, the drive's input power may have to be cycled to restart a fault.

### **Bidirectional Autospeed Search**

Allows starting into a "windmilling" fan at any speed, in either direction. This function makes it possible to catch a motor which is spinning freely due to a mains drop-out.

### **Torque Boost**

The TR200 Drive's constant-torque start mode provides full torque to accelerate different loads until the drive reaches the setpoint. Breakaway current can be set up to 160% for up to 0.5 seconds for starting high friction loads.

### **Stall Protection**

The TR200 Drive provides protection against a stalled motor. When activated, this function can provide a warning or a fault condition caused by excessive motor current at low speeds.

### **Three-Phase Output Current Measurement**

The TR200 Drive's software measures output current on all three phases. Phase grounding is detected instantly. Output contactors may be repeatedly used with no damage to the drive. Multiple motors may be run from one drive.

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### **Automatic Energy Optimization Circuitry**

The Automatic Energy Optimization (AEO) function adapts the output of the drive to the specific motor and load connected. This circuit optimizes the system efficiency as system loads change. The AEO function regulates the output voltage on the basis of the reactive current and the effective current. A savings of 3 to 10% in power consumption can be obtained with this function.

### **Automatic Motor Adaptation (AMA)**

Knowing motor stator resistance, the drive automatically optimizes performance and efficiency. The motor does not have to be run or decoupled from the load for the AMA setup to be performed.

### **Broken Belt, Loss of Load**

A minimum motor current value can be set to indicate the motor is not using any more current than to run at idle. This can be used to indicate a broken belt or coupler. This feature can also be used to detect when a motor is disconnected from the drive.

### **Energy Monitoring**

Real energy savings are always available without the additional expense of external equipment.

### **Preset Speeds**

The TR200 Drive allows for a maximum of 16 programmable preset speeds to be selected from the digital inputs.

### **Preventive Maintenance Scheduling**

The TR200 Drive can monitor system usage and notify the operator when preventive maintenance is required.

## **TR200 DRIVE – CONTROLS AND INDICATIONS**

### **Panel-mounted Operator Station**

The TR200 Drive uses a large, bright, backlit graphic display to provide complete drive information at a glance. The logical arrangement of all elements simplifies the setup, operation and monitoring of the drive. Choose from 25 different items to display, including input reference, motor current, hours run, output frequency, horsepower, kW or kWh. Or select from custom units, such as GPM or HP and calibrate the maximum value to the maximum frequency of the unit. After programming one drive, the keypad can be used to transfer the same settings to all other drives. Drive can run without the keypad in place to assure tamper-proof operation. Drive status is shown even with the keypad removed.

### **Application-Specific Software**

The TR200 Drive was designed specifically for the HVAC market. This specialization has allowed TRANE to factory program and configure the TR200 Drive to make it ready to use, out of the box. For the advanced user, the parameters are logically grouped, making modifications simple. Customized text fields are available to show user-specific data. Four independent setups are available for unmatched flexibility.

### **Status Lights**

Three LEDs are provided on the TR200 Drive for indication of power applied, warning and fault. Upon power up, all LEDs will briefly light as a lamp test.

- Alarm – Will flash red when the drive has registered a fault condition which has caused the drive to shut down.
- Warning – Will flash yellow to indicate a situation exists that exceeds the normal drive/system parameters, and if that condition continues, a trip may be imminent.
- On – Will glow green to indicate that the VFD is connected to AC power (line voltage is present) In addition to the status lights, up to five separate meters can be displayed simultaneously Operating Keys for four conditions of control authority:
- Off – Stops the motor, regardless of other commands.
- Hand On – Starts the VFD in Local control. An external Stop signal overrides the local Hand On.
- Auto/On – The drive will start and stop via a remote signal (BAS or time clock).
- Reset – Will reset any trip level fault (not trip lock) if the drive is not set for infinite automatic fault resets.

### **Menu Structure**

- Quick Setup Menu – Contains the 14 required setup parameters to easily start the application.
- HVAC Application Menu – Easy access to the relevant parameters for each of the most common applications.
- Personal Menu – Contains up to 20 user-selectable parameters for customized access.
- Changes Made Menu – Provides easy access to previously modified parameters Directional keys
- Right / Left / Up / Down arrows – Used as the electronic potentiometer to manually control the speed in the Hand/Start mode. All four keys are active during operation as well as programming. They provide the ability to move the cursor around the display, or sequence through display values.

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## Programming Keys

- Status – Used to display operational data and status.
- Cancel – Used to cancel the last programming command so the change is not carried out.
- OK – Used to confirm that the last programming change should be saved to memory.
- Back – Used to exit present display or menu to the previous display or menu.
- Quick Menu – Used for programming the TR200 Drive for the most typical applications.
- Main Menu – Used to access all parameters for programming; it can switch directly from this to quick menu
- Alarm Menu – Used to access all fault and warning data.
- Info Key – Accesses an on-board manual that gives detailed explanation of a parameter.

## Additional Keypad Features

- Hot-pluggable with upload and download capabilities, On-screen scroll bars and graphs
- Three-level password protection: No Access, Read-only and Full Access
- Plain language alarms and warnings
- Remote keypad mounting kits available

## Control Signal Interfaces

- Two Programmable Analog inputs: scalable 0 to 10 VDC or 0/4 to 20mA
- Six Programmable Multi-functional Digital Inputs
- One Programmable Analog output: 0/4 to 20mA
- 2 Programmable Relay outputs: 240 VAC, 2 amp
- PID Control Interface: four auto-tuning PIDs control the drive and up to three other devices, eliminating external controllers and reducing cost

## TR200 DRIVE - CUSTOM APPLICATIONS

### Run Permissive Circuit

Ability to accept a "system ready" signal assures that dampers or other auxiliary equipment are in the proper state for drive operation. This feature also provides the ability for the drive to send a "start signal applied" signal to the system to notify the auxiliary equipment of the drive's request to start.

### Sleep Function

Automatically stops the drive when speed drops below set "sleep" level for specified time. Automatically restarts when speed command exceeds set "wake" level. Saves energy and reduces wear on driven equipment.

### Motor Preheat Function

This preheat function can be activated to avoid condensation on the motor windings when it is stopped.

### Firefighter's Override Mode

Overrides all other commands to provide desired operation. Ignores most alarms including overload, overcurrent, over temperature, and phase loss. When used with bypass, selectable to run from drive, from bypass, or switch from drive to bypass in the event of a drive failure. Fire Mode is clearly indicated on the TR200 display to prevent any confusion.

### BAS Interface

The TR200 Drive is fully equipped for serial communication (EIA-485). Up to 31 drives can be connected to one serial bus up to 5,000 feet long. The TR200 communicates directly with, BACnet MS/TP, Johnson Controls Metasys (N2), Siemens Building Technologies System 600 (FLN), and Modbus RTU systems with no hardware changes or additional costs. **Optional communications:** include an Advanced *BACnet MS/TP* and *LonWorks* by adding an Option A card.

### USB Connectivity

The TR200 Drive can be remotely commissioned and monitored through a standard USB connection and Trane Drive Utility PC software.

## TR200 DRIVE - ENCLOSURES

TR200 enclosures comply with NEMA 250 and include UL labeling.

### Plenum Rated

The TR200 NEMA 1 and NEMA 12 drive enclosures are recognized by UL for installation in air handling compartments.

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## TR200 DRIVE - ELECTRO-MECHANICAL BYPASS SYSTEM

### General Features

All optional features shall be built, mounted and tested by TRANE. The factory warranty will apply to the entire assembly as shipped. All options will carry a UL / C-UL Enclosed Industrial Control Panel label. All optional devices will be factory tested as assembly.

### Bypass Power Features

- Contactor bypass will be provided that allows operation of the motor via line power in the event of a failure of the VFD. Motor control selection shall be through either a VFD output contactor or a bypass contactor that is interlocked to ensure that both contactors are not energized simultaneously.
- Main input disconnect will be provided that removes power from both the bypass and VFD
- VFD-only, fast acting input fuses will be provided
- Overload protection will be supplied in bypass mode
- Adjustable current setting for complete motor protection when operating on line power
- Overload protection shall include phase loss and phase imbalance protection
- Visual indication of an overload trip condition shall be displayed on the VFD keypad
- Resetting an overload trip condition shall not require the opening of the enclosure door for safety reasons and shall be accomplished via a digital input, door mounted device (drive keypad), or over the serial communications

### Bypass Interface and Control Features

- Bypass or VFD selection shall be via a DRIVE – OFF – BYPASS selector switch
- A BYPASS pilot light will illuminate when operating in bypass mode
- A TEST switch position is provided on units that include an optional drive input contactor. This shall allow the ability to supply power to the drive for testing purposes while running the motor in bypass.
- Selection of Bypass or VFD operation will be by any one of the following: manually, via the VFD selector switch or automatic bypass operation based on VFD programming
- Bypass package will include an External Safety interlock that will disable motor operation in either bypass or VFD mode when open

### Common Start/Stop command:

- While operating in Bypass mode, the keypad shall allow the selection of Hand or Remote motor starting. In Hand-and-Bypass modes, pushing the keypad start button shall initiate motor operation via line power. When Remote and Bypass modes are selected, the motor shall start just as it would have in VFD and Remote mode. This start source can be via either a hardwired start command, the VFD's real time clock or a command over BAS communication. This feature allows energy savings over standard bypass packages by allowing nighttime shutdown schedules and load shedding even with a VFD failure.
- Selectable Run Permissive logic shall operate in either VFD or bypass operation. When activated, any command to start the motor, in either Hand Bypass, Remote Bypass, Hand VFD or Remote VFD shall not start the motor, but instead close a relay contact that is used to initiate operation of another device, such as an outside air damper. A contact closure from this device shall confirm that it is appropriately actuated and the motor shall then start.
- Firemode operation input shall be available. When closed, the motor will run in bypass mode regardless of operating mode selected and will ignore calls to stop. These include the opening of the external safety interlock circuit or the tripping of the motor overload.
- In additional to the power and operational protective features listed above, each bypass will include the following:
  - Low voltage contactor operation shall be maintained to 70% of the package's nominally rated voltage. This will ensure VFD operation on low voltage conditions that would otherwise be interrupted due to contactor dropout.
  - The VFD shall be able to operate the motor at a reduced load with the loss of any one of the three phases of power. Contactors shall remain closed regardless of which phase is lost. This will ensure VFD operation on single-phase conditions that would otherwise be interrupted due to contactor dropout.

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## TR200 SPECIFICATIONS

### Drive Input Power

Input voltage, 3 phase .....	200–240, or 380–460, or 525–600 VAC
Input voltage range for full output .....	Nominal $\pm 10\%$
Undervoltage trip point .....	164, 313 VAC, or 394 VAC
Overvoltage trip point.....	299, 538, or 690 (792 for 100 HP and above) VAC
Input frequency .....	60 Hz, $\pm 2$ Hz
Displacement power factor .....	0.98 or greater at all speeds and loads
Total power factor .....	0.90 or greater at full load and nominal motor speed

### Drive Output Power

Output frequency .....	Selectable 0 to 120 Hz
Motor voltages .....	200, 208, 220, 230; 380, 400, 415, 440, 460; 550 or 575 VAC
Continuous output current .....	100% rated current
Output current limit setting.....	Adjustable to 110% of drive rating
Current limit timer .....	0 to 60 seconds or infinite
Adjustable maximum speed .....	From minimum speed setting to 120 Hz
Adjustable minimum speed .....	From maximum speed setting to 0 Hz
Acceleration time .....	To 3,600 seconds to base speed
Deceleration time.....	To 3,600 seconds from base speed
Breakaway torque time.....	0.0 to 0.5 seconds (1.6 times motor nameplate current)
Start voltage.....	0 to 10%
DC braking time .....	0 to 60 seconds
DC braking start.....	0 to maximum frequency
DC braking current.....	0 to 50% of rated motor current

### Environmental limits:

Efficiency .....	97% or greater at full load and nominal motor speed
Ambient operating temperature .....	14°F to 113°F (frames A2–C2); 14°F to 104°F (frames D1–E1)
Humidity .....	< 95%, non-condensing
Altitude: maximum without derating.....	3,300 ft.
Drive and options enclosure(s).....	NEMA/UL Types 1 and 12; 3R optional

### Software

Lost speed reference action.....	Selectable to go to a preset speed, go to maximum speed, stay at last speed, stop, turn off, or stop and trip
Time delay for lost speed reference action .....	1 to 99 seconds
Adjustable auto restart time delay .....	0 to 600 seconds
Automatic restart attempts.....	0 to 20 or infinite
Automatic restart time delay .....	0 to 600 seconds between each attempt
Relay ON delay and relay OFF delay .....	0 to 600 seconds
Maximum number of preset speeds .....	16
Maximum number of frequency stepovers .....	4
Maximum stepover width.....	100 Hz
Maximum number of accel rates .....	4
Maximum number of decel rates .....	4
Delayed Start .....	0 to 120 seconds
Protections:	
Low frequency and high frequency warnings .....	0 to 120 Hz
Low current and high current warnings .....	0 to maximum current
Low reference and high reference warnings .....	–999,999 to 999,999
Low feedback and high feedback warnings .....	–999,999 to 999,999
Ground fault .....	Protected
Motor stall .....	Protected
Motor overtemperature .....	Protected (Predictive motor temperature)
Motor Condensation .....	Protected (Motor preheat circuit)
Motor overload.....	Protected (Programmable action)
The unit is suitable for use on a circuit capable of delivering not more than 100,000 RMS symmetrical Amperes, 480/600 V maximum.	
Vibration protection .....	Protected (Programming automated)

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**Control Connections**

Follower signal, analog input.....2; selectable voltage or current, direct and inverse acting  
Programmable digital inputs ..... 6 (2 can be used as digital outputs)  
Programmable analog outputs ..... 1; 0/4 to 20 mA  
Programmable relay outputs .....2 standard Form C 240 V AC, 2 A; 1 or 3 additional optional  
Auxiliary voltage..... +24 V DC, maximum 200 mA

**Agency Listings**

All drives and option packages are factory built and carry UL and C-UL listings.  
All drives and option packages are built in ISO 9000 and 14001 certified facilities.  
Electrical components and devices are listed and labeled as defined in NFPA 70, Article 100.  
All drives comply with NFPA 70.

